99-56.

NUCLEAR POWERPLANT DESIGN STANDARDIZATION

HEARINGS
BEFORE THE
SUBCOMMITTEE ON
ENERGY CONSERVATION AND POWER
OF THE
COMMITTEE ON
ENERGY AND COMMERCE
HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS
FIRST SESSION

ON

H.R. 1029, H.R. 1447, and H.R. 2488
BILLS TO AMEND THE ATOMIC ENERGY ACT REGARDING THE STANDARDIZATION OF NUCLEAR POWERPLANT DESIGNS

JULY 25, DECEMBER 10, 1985

Serial No. 99-56

Printed for the use of the Committee on Energy and Commerce

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NUCLEAR POWERPLANT DESIGN STANDARDIZATION

THURSDAY, JULY 25, 1985

House of Representatives,
Committee on Energy and Commerce,
Subcommittee on Energy Conservation and Power,
Washington, DC.

The subcommittee met, pursuant to notice, at 2 p.m., in room 2359-A, Rayburn House Office Building, Hon. Edward J. Markey (chairman of the subcommittee) presiding.

Mr. Markey. This is the hearing of the Subcommittee on Energy Conservation and Power.

Good afternoon and welcome to the first in our series of hearings on the problems affecting the nuclear industry. As you may know, a number of bills have been introduced to modify the NRC system of safety regulation and licensing. Others would change the NRC's organization.

[The bills mentioned, H.R. 1029, H.R. 1447, and H.R. 2488 follow:]

I

99TH CONGRESS
1ST SESSION

H. R. 1029

To amend the Atomic Energy Act of 1954 to encourage the development and use of standardized plant designs and improve the nuclear licensing and regulatory process.

IN THE HOUSE OF REPRESENTATIVES

FEBRUARY 7, 1985

Mr. BROYHILL (for himself, Mr. MOORHEAD, Mr. RALPH M. HALL, Mr. SHELBY, Mr. RITTER, Mr. LUJAN, Mrs. LLOYD, Mr. YOUNG of Alaska, Mr. MURPHY, Mr. BLILEY, Mr. WHITTAKER, Mr. DANNEMEYER, Mr. MORRISON of Washington, Mr. SKEEN, and Mr. MYERS of Indiana) introduced the following bill; which was referred jointly to the Committees on Energy and Commerce and Interior and Insular Affairs

---

A BILL

To amend the Atomic Energy Act of 1954 to encourage the development and use of standardized plant designs and improve the nuclear licensing and regulatory process.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SHORT TITLE

SECTION 1. This Act may be cited as the "Nuclear Powerplant Standardization Act of 1985".

FINDINGS AND PURPOSES

SEC. 2. (a) The Congress, recognizing that a clear and coordinated energy policy consistent with public health and safety must include an effective and efficient licensing process for the siting, construction, and operation of nuclear powerplants that meet applicable criteria, hereby finds that—

(1) interstate commerce is substantially affected by the siting, construction, and operation of nuclear powerplants;

(2) opportunity for meaningful public participation in the siting and licensing of nuclear powerplants should be assured;

(3) the licensing and construction of nuclear powerplants will be facilitated and the public health and safety enhanced by the use of preapproved nuclear powerplant designs, particularly standardized designs;

(4) there is a need to encourage the development and use of standardized nuclear powerplant designs because (A) such designs can benefit public health and safety by concentrating the resources of designers, engineers, and vendors on particular approaches, by stimulating standardized programs of construction practice and quality assurance, by improving the training of personnel, and by fostering more effective maintenance and improved operations; and (B) the use of such de-

signs can permit a more effective and efficient licensing and inspection process;

(5) the licensing process will be facilitated by procedures for the selection and approval of a site for a nuclear powerplant to be accomplished in advance of a commitment to construct a particular facility of a specific design at such site;

(6) the licensing and regulatory process will be facilitated if licensing decisions are made at the earliest feasible phase of the process and issues resolved in Nuclear Regulatory Commission proceedings are not subject to further adjudication in the absence of a substantial evidentiary showing required by this Act and the regulations of the Nuclear Regulatory Commission;

(7) consistent with the adequate protection of the public health and safety and the common defense and security, the regulatory process should provide greater stability in licensing standards and criteria for approved designs of nuclear powerplants; and

(8) consistent with the paramount responsibility of the Nuclear Regulatory Commission to protect the public health and safety, and recognizing that the elimination of all risk is an unattainable goal for any energy source, it is appropriate and in the public interest for the Nuclear Regulatory Commission to consider

the economic consequences of its regulatory practices, including the cost of safety requirements.

(b) The purposes of this Act are—

(1) to facilitate the use of preapproved sites and designs for nuclear powerplants and to facilitate the development and use of standardized designs;

(2) to provide for the issuance of a license to construct and operate a nuclear powerplant under conditions that enhance the protection of the public health and safety and are in accord with the common defense and security; and

(3) to improve the stability of licensing standards, criteria for nuclear powerplants, and prior Nuclear Regulatory Commission licensing approvals.

TITLE I—LICENSING AND REGULATORY PROCESS

APPROVAL OF STANDARDIZED DESIGNS

SEC. 101. (a) The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) is amended by inserting after section 192 the following new section:

"SEC. 193. APPROVAL OF STANDARDIZED DESIGNS.—

"a. (1) The Commission shall establish procedures, standards, and criteria permitting the approval of standardized facility designs for any utilization or production facility for industrial or commercial purposes, or any discrete subsystem thereof, for a period of ten years, notwithstanding the fact that an application has not been filed for a construction permit or license to construct and operate for such facility. For purposes of this Act, a design approval shall be considered to be a license.

"(2) A design approval issued by the Commission under this section shall be conclusive with respect to an application for a construction permit, an operating license, or a license to construct and operate that meets the conditions of the approval and is filed within the period during which the approval remains valid.

"b. The Commission shall establish procedures for the renewal of design approvals issued under subsection a. for additional ten-year periods from the date of renewal. Upon application for renewal of a design approval, the Commission shall renew the approval unless it finds that significant new information relevant to the design has become available that makes it likely that the design will not comply with this Act or the rules and regulations of the Commission for protection of the public health and safety or the common defense and security.

"c. Notwithstanding section 161 w. of this Act or section 9701 of title 31, United States Code, an application filing or issuance fee shall not be required for an application for approval, or for an amendment or renewal of an approval, of a design or discrete subsystem under this section. The Commission may allocate the costs that would otherwise have been defrayed by fees required of applicants under this section among applicants for permits or licenses who propose to use the approved design. If no application for construction of a facility is filed within the initial ten-year approval period, any outstanding fee shall become immediately due and payable by the applicant for the design approval.

"d. A final Commission determination on an application filed under this section shall be considered to be a final order of the Commission for purposes of section 189 b.

"e. Following the issuance of a design approval under this section, and in any subsequent Commission proceeding involving a facility design for which a design approval has been granted under this section, the Commission may not modify any final determination with respect to the design approval, except that any party to such proceeding or any other person may petition the Commission at any time for an amendment to the design approval.

"f. The holder of a permit, license, or approval may deviate from any aspect of the permit, license, or approval without prior Commission approval unless the deviation involves a change in technical specifications incorporated in the permit, license, or approval or an unreviewed safety question.

A deviation that involves changes to technical specifications or unreviewed safety problems shall be proposed to the Commission as an amendment to the permit, license, or approval.".

(b) The table of contents of the Atomic Energy Act of 1954 (42 U.S.C. 2011 prec.) is amended by adding at the end of the items relating to chapter 16 the following new item:

"Sec. 193. Approval of Standardized Designs.".

EARLY SITE APPROVAL

SEC. 102. (a) The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) is amended by inserting after section 193, as inserted by this Act, the following new section:

"SEC. 194. EARLY SITE APPROVAL.—

"a. (1) The Commission shall establish procedures, standards, and criteria permitting the approval of a site or sites for one or more utilization or production facilities for industrial or commercial purposes for a period of ten years, notwithstanding the fact that an application has not been filed for a construction permit or a license to construct and operate for such facility.

"(2) If, after considering such information as the Commission may by rule or regulation require, the Commission determines a proposed site is suitable for the construction and operation of one or more utilization or production facilities for industrial or commercial purposes consistent with public health and safety and the common defense and security, it shall issue a site permit subject to such conditions as it considers appropriate. For purposes of this Act, a site permit shall be considered to be a license.

"(3) A site permit issued by the Commission under this section shall be conclusive with respect to an application for a construction permit, an operating license, or a license to construct and operate that meets the conditions of the site permit and is filed within the period during which the site permit remains valid.

"b. The Commission shall establish procedures for the renewal of site permits approved under subsection a. for additional ten-year periods from the date of renewal. Upon application for renewal of a site permit, the Commission shall renew the site permit unless it finds that significant new information on the site has become available that makes it likely that the site will not comply with this Act or the rules and regulations of the Commission for protection of the public health and safety or the common defense and security.

"c. Approval of a site under this section shall not preclude its approval and use as a site for an alternate or modified type of energy facility or for any other purpose.

"d. A final Commission determination on an application filed under this section is a final order of the Commission for purposes of section 189 b.".

(b) The table of contents of the Atomic Energy Act of 1954 (42 U.S.C. 2011 prec.) is amended by inserting after the item relating to section 193, as inserted by this Act, the following new item:

"Sec. 194. Early Site Approval.".

CONSTRUCTION AND OPERATING LICENSES

SEC. 103. (a) Section 185 of the Atomic Energy Act of 1954 (42 U.S.C. 2235) is amended to read as follows:

"SEC. 185. CONSTRUCTION PERMITS, OPERATING LICENSES, AND CONSTRUCTION AND OPERATING LICENSES.—

"a. An applicant for a license to construct or modify a utilization or production facility for industrial or commercial purposes shall, after the Commission has provided an opportunity for public hearing pursuant to section 189 and if the application establishes competency and is otherwise acceptable to the Commission, be initially granted a construction permit. Upon the filing of additional information by the applicant needed to bring the original application up to date, the Commission shall, after providing an opportunity for public hearing pursuant to section 189, issue an operating license to the applicant upon finding that the facility authorized has been constructed and will operate in conformity with the application as amended, the provisions of this Act, and the rules and regulations of the Commission. For purposes of this Act, a construction permit shall be considered to be a license.

"b. (1) The Commission may issue a license to an applicant to construct and operate a utilization or production facility for industrial or commercial purposes after providing an opportunity for public hearing pursuant to section 189, if the application is sufficient to enable the Commission to determine that the applicant is competent and that the facility will be constructed and will operate in conformity with the application, the provisions of this Act, and the rules and regulations of the Commission. For purposes of this Act, a license to construct and operate shall be considered to be a license.

"(2)(A) Not less than nine months prior to the date on which the holder of a license issued under this subsection desires to commence operation of a facility, the holder shall notify the Commission in writing of the proposed date of initial operation. Upon receipt of this notice, the Commission shall publish in the Federal Register a notice of its receipt, and shall provide a thirty-day period during which any person may file a written objection to the commencement of operation on the basis that the facility authorized has not been constructed or will not operate in conformity with the license to construct and operate. Such objection shall set forth in reasonable detail the facts and arguments upon which the objection is based, and may be accompanied by a request for a hearing.

"(B) If a hearing is requested under subparagraph (A), the Commission shall determine whether good cause exists for holding a hearing with respect to such objection and shall designate the issues to be the subject of the hearing. The Commission may designate an issue for a hearing only if—

"(i) the issue was not and could not have been raised and resolved in any proceeding for the issuance of a permit or license for that facility, facility site, or approval of design for that facility;

"(ii) the issue consists of a genuine and substantial dispute of fact that cannot be resolved with sufficient accuracy except at a hearing;

"(iii) the decision of the Commission will depend in whole or in part on the resolution of the issue; and

"(iv) with respect to an issue involving the verification, inspection, and testing necessary to determine whether the facility has been constructed and will operate in accordance with the license, a showing has been made that (I) there has been nonconformance with the license; and (II) such nonconformance could materially and adversely affect the safe operation of the facility.

"(C) Following completion of any hearing held pursuant to subparagraph (B), the Commission shall decide whether the license to construct and operate should be modified.".

(b) The item relating to section 185 in the table of contents of the Atomic Energy Act of 1954 (42 U.S.C. 2011 prec.) is amended to read as follows:

"Sec. 185. Construction Permits, Operating Licenses, and Construction and Operating Licenses.".

MODIFICATION OF REGULATORY REQUIREMENTS

SEC. 104. (a) The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) is amended by inserting after section 29 the following new section:

"SEC. 30. MODIFICATION OF REGULATORY REQUIREMENTS.—

"a. Not later than one hundred and eighty days after the date of the enactment of the Nuclear Powerplant Standardization Act of 1985, the Commission shall adopt regulations setting forth criteria to govern all additions, deletions, and modifications to Commission regulatory requirements. A proposed change to the regulatory requirements shall only be approved if the Commission determines that the proposed change will substantially enhance the public health and safety or the common defense and security as a result of improved overall safety of facility operation, and that the overall improvement is justified.

"b. The regulations required in subsection a. shall require a systematic, centralized, and documented review of the concerns that give rise to the proposed change, the improvements in safety that would result from adoption of the proposed change, estimates of costs or other impacts on potentially affected licensees and the public, taking into account, if facility-specific, the remaining life of the facility, and such other matters as the Commission determines to be necessary.

"c. All additions, deletions, and modifications of permits, licenses, or approvals shall be made by rule, regulation, or order, except that such requirements may be made immediately effective if the Commission determines that absent immediate action the public health and safety or the common defense and security will not be adequately protected.".

(b) The table of contents of the Atomic Energy Act of 1954 (42 U.S.C. 2011 prec.) is amended by inserting after the item relating to section 29 the following new item:

"Sec. 30. Modification of Regulatory Requirements.".

FINALITY OF PREVIOUSLY RESOLVED ISSUES

SEC. 105. Section 189 a. (1) of the Atomic Energy Act of 1954 (42 U.S.C. 2239(a)(1)) is amended—

(1) by inserting "(A)" after "(1)"; and

(2) by adding at the end thereof the following new subparagraph:

"(B) In making any determination in any proceeding under this Act, the Commission need not consider or reconsider any issue that has been resolved in any other proceeding under this Act, in the absence of significant new information substantially affecting the conclusions reached in such other proceeding.".

TITLE II—TECHNICAL AND CONFORMING AMENDMENTS

ANTITRUST PROVISIONS

SEC. 201. Section 105 c. (2) of the Atomic Energy Act of 1954 (42 U.S.C. 2135(c)(2)) is amended by striking out "a license to construct or operate" and inserting in lieu thereof the following: "a site permit and an application for a license to construct, operate, or construct and operate".

LICENSE APPLICATIONS

SEC. 202. Section 182 b. of the Atomic Energy Act of 1954 (42 U.S.C. 2232(b)) is amended by inserting "or construction and operating license" after "operating license" each place it appears.

REVOCATION

SEC. 203. Section 186 a. of the Atomic Energy Act of 1954 (42 U.S.C. 2236(a)) is amended—

(1) by inserting "193, or 194," after "182,"; and

(2) by inserting "or site permit or design approval" after "license" each place it appears.

MODIFICATION OF LICENSE

SEC. 204. Section 187 of the Atomic Energy Act of 1954 (42 U.S.C. 2237) is amended by inserting ", site permits, and design approvals" after "licenses".

HEARINGS AND JUDICIAL REVIEW

SEC. 205. Section 189 a. of the Atomic Energy Act of 1954 (42 U.S.C. 2239(a)) is amended—

(1) in the first sentence of paragraph (1), by inserting "construction and operating license," after "construction permit,";

(2) in the second sentence of paragraph (1), by inserting "or construction and operating license" after "construction permit" each place it appears;

(3) in the third sentence of paragraph (1), by inserting "or construction and operating license" after "construction permit" the first place it appears;

(4) in paragraph (1), by inserting "or construction and operating license" after "operating license" the second and third places it appears; and

(5) in paragraph (2), by inserting "or construction and operating license" after "operating license" each place it appears.

ATOMIC SAFETY AND LICENSING BOARD

SEC. 206. Section 191 a. of the Atomic Energy Act of 1954 (42 U.S.C. 2241) is amended—

(1) by striking out "or" after "license" and inserting in lieu thereof a comma; and

(2) by inserting "or site permit or design approval after "authorization".

CONFORMING REFERENCES TO TITLES 5 AND 28, UNITED STATES CODE

SEC. 207. (a) Section 181 of the Atomic Energy Act of 1954 (42 U.S.C. 2231) is amended—

(1) by striking out "the Administrative Procedure Act (Public Law 404, Seventy-ninth Congress, approved June 11, 1946)" and inserting in lieu thereof "subchapter II of chapter 5, and chapter 7, of title 5, United States Code,"; and

(2) by striking out "the Administrative Procedure Act:" and inserting in lieu thereof "section 551 of such title:".

(b)(1) Section 186 b. of the Atomic Energy Act of 1954 (42 U.S.C. 2236(b)) is amended by striking out "section 9(b) of the Administrative Procedure Act" and inserting in lieu thereof "section 558(c) of title 5, United States Code,".

(2) Section 186 c. of the Atomic Energy Act of 1954 (42 U.S.C. 2236(c)) is amended by striking out "the Administrative Procedure Act" and inserting in lieu thereof "subchapter II of chapter 5, and chapter 7, of title 5, United States Code".

(c) Section 189 b. of the Atomic Energy Act of 1954 (42 U.S.C. 2239(b)) is amended—

(1) by striking out "the Act of December 29, 1950, as amended (ch. 1189, 64 Stat. 1129)" and in-

serting in lieu thereof "chapter 158 of title 28, United States Code"; and

(2) by striking out "section 10 of the Administrative Procedure Act, as amended" and inserting in lieu thereof "chapter 7 of title 5, United States Code".

(d) Section 191 a. of the Atomic Energy Act of 1954 (42 U.S.C. 2241(a)) is amended by striking out "sections 7(a) and 8(a) of the Administrative Procedure Act" and inserting in lieu thereof "sections 556(b) and 557(b) of title 5, United States Code".

○

I

99TH CONGRESS
1ST SESSION

H. R. 1447

To amend the Atomic Energy Act of 1954, as amended, to improve the nuclear powerplant siting and licensing process, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

MARCH 6, 1985

Mr. UDALL (by request) introduced the following bill; which was referred jointly to the Committees on Energy and Commerce and Interior and Insular Affairs

---

A BILL

To amend the Atomic Energy Act of 1954, as amended, to improve the nuclear powerplant siting and licensing process, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Nuclear Powerplant Licensing and Standardization Act of 1985".

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TITLE IV—EFFECTIVE DATE

Sec. 401. Effective date.

FINDINGS AND PURPOSES

SEC. 2. (a) The Congress, recognizing that a clear and coordinated energy policy consistent with public health and safety must include an effective and efficient licensing process for siting, construction, and operation of nuclear powerplants which meet applicable criteria, finds and declares that—

(1) interstate commerce is substantially affected by the siting, construction, and operation of nuclear powerplants;

(2) opportunity for public participation in siting and licensing of nuclear powerplants should be assured;

(3) the licensing and construction of nuclear powerplants would be facilitated and the public health and safety enhanced by the use of preapproved nuclear powerplant designs, particularly standardized designs;

(4) there is a need to encourage the development and use of standardized nuclear powerplant designs because such designs can benefit public health and safety by concentrating the resources of designers, engineers,

and vendors on particular approaches, by stimulating standardized programs of construction practice and quality assurance, by improving the training of personnel and by fostering more effective maintenance and improved operations, and because the use of such designs can permit a more effective and efficient licensing and inspection process;

(5) the licensing process would be facilitated by procedures for the selection and approval of a site for a nuclear powerplant to be accomplished in advance of a commitment to construct a particular facility of a specific design at that site;

(6) the licensing process would be facilitated if licensing decisions are made at the earliest feasible phase of the process and, if an opportunity for hearing has been provided, licensing issues are not subject to further adjudication in the absence of an evidentiary showing called for by this Act and the regulations of the Commission;

(7) all phases of the licensing process should be handled in a timely manner under procedures which, consistent with this Act and the regulations of the Commission, assure that adjudicatory procedures are only invoked where a relevant dispute can only be re-

solved with sufficient accuracy through such procedures;

(8) consistent with the adequate protection of the public health and safety and the common defense and security, the regulatory process should provide greater stability in licensing standards and criteria for approved designs of nuclear power plants;

(9) consistent with the Commission's paramount responsibility to protect the public health and safety, and recognizing that elimination of all risk is an unattainable goal for any energy source, it is appropriate and in the public interest for the Commission to consider the economic consequences of its regulatory practices including, but not limited to, the cost of safety requirements; and

(b) The purposes of this Act are—

(1) to facilitate the use of preapproved sites and designs for nuclear power plants and to facilitate the development and use of standardization designs;

(2) to provide for the issuance of a combined license to construct and to operate a nuclear power plant under conditions which assure the continued protection of the public health and safety and which will be in accord with the common defense and security;

(3) to improve the stability of licensing standards and criteria for nuclear power plants and thus the finality of prior Commission licensing approvals; and

TITLE I—SITING AND LICENSING

CONSTRUCTION PERMIT AND OPERATING LICENSES

SEC. 101. Section 185 of the Atomic Energy Act of 1954, as amended, is amended to read as follows:

"SEC. 185. CONSTRUCTION PERMITS AND OPERATING LICENSES.—

"a. All applicants for licenses to construct or modify production or utilization facilities shall be initially granted a construction permit after the Commission has provided an opportunity for public hearing pursuant to section 189 of this Act and if the application is otherwise acceptable to the Commission. Upon the completion of the construction or modification of the facility, upon the filing of any additional information needed to bring the original application up to date, after providing an opportunity for public hearing pursuant to section 189 of this Act, and upon finding that the facility authorized has been constructed and will operate in conformity with the application as amended and in conformity with the provisions of this Act and of the regulations of the Commission, and in the absence of any good cause being shown to the Commission why the granting of an operating license would not be in accordance with the provisions of this

Act, the Commission shall thereupon issue an operating license for the applicant. For all other purposes of this Act, a construction permit is a 'license.'.

"b. Notwithstanding any other provision of this section, the Commission shall issue to the applicant a combined construction permit and operating license for a thermal neutron power generation facility after providing an opportunity for public hearing pursuant to section 189 of this Act, if the application contains sufficient information to support the issuance of a combined construction permit and an operating license in accordance with the regulations of the Commission and the Commission determines that there is a reasonable assurance that the facility will be constructed and will operate in conformity with the application, the provisions of this Act, and the rules and regulations of the Commission. The Commission shall identify within such combined construction permit and operating license the inspections, tests, and analyses which shall be performed and the acceptance criteria therefor which will provide reasonable assurance that the plant has been constructed and will operate in accordance with the license. After issuance of a combined construction permit and operating license for a thermal neutron power generation facility, the Commission shall assure through inspections, tests and analyses that construction is completed in conformity with the combined construction permit and operating license, consistent with the regulations of the Commission.

"Prior to the commencement of operation of any facility licensed under this subsection, the Commission shall publish in the Federal Register a notice of the intended operation of such facility, and shall provide a thirty-day period during which any person may file a written objection to the commencement of operation on the basis that the facility authorized has not been constructed or will not operate in conformity with the license. Such objection shall set forth in reasonable detail the facts and arguments upon which the objection is based, and may be accompanied by a request for a hearing.

"If a hearing is requested, the Commission shall determine whether good cause exists therefor and, if so, the issues to be heard and whether the hearing must precede commencement of operation of the facility in order to provide reasonable assurance of the protection of the public health and safety and common defense and security. The Commission may designate an issue for a hearing only if the issue consists of a substantial dispute of fact, necessary for the Commission's decision, that cannot be resolved with sufficient accuracy except at a hearing and:

"(i) the issue was not and could not have been raised and resolved in any proceeding for the issuance, modification or amendment of a license, permit, or approval for that facility, its site, or design; or

"(ii) a showing has been made that (I) there has been nonconformance with the license; (II) such nonconformance has not been corrected; and (III) such nonconformance could materially and adversely affect the safe operation of the facility.

"Following completion of any hearing held, the Commission shall decide whether the license to construct and operate should be modified. Operation of the facility shall commence based on the combined construction permit and operating license unless the Commission determines that good cause exists for delaying such operation.

"c. The Commission shall not modify any final determination on an issue that has been considered and decided in any proceeding for the issuance of a permit or license for that facility, facility site, or approval of design for that facility under section 194, unless it determines, based on significant new information, that a modification is required to protect the public health and safety or the common defense and security and that the modification proposed will substantially enhance the public health and safety or the common defense and security by improving overall safety of facility operation.".

EARLY SITE REVIEW

SEC. 103. The Atomic Energy Act of 1954, as amended, is amended by adding a new section 193 to read as follows

SEC. 193. EARLY SITE REVIEW.—

"a. The Commission is authorized to issue a site permit for approval of a site or sites for one or more production or utilization facilities for a period of ten years upon the application of any person or entity notwithstanding the fact that no application for a construction permit or a combined construction permit and operating license for such facility or facilities has been filed. The Commission may issue a site permit with respect to limited aspects of the suitability of the site for its intended purpose, under relevant regulations of the Commission

"b. Notwithstanding section 161 w. of this Act or the Independent Offices Appropriation Act of 1952, no application filing or issuance fees shall be required for an application for a site permit, an amendment, or a renewal of a site permit under this section. The Commission is authorized to allocate the ocsts that would otherwise have been defrayed by fees required of applicants under this section among applicants for permits or licenses which propose to use the approved site in a manner that will assure full cost recover by the Commission. If no application for construction of a production or utilization facility is filed within the initial ten-year approval period, any outstanding fee shall become immediately due and payable by the applicant for the site permit.

"c. After considering all information submitted in the application and after providing an opportunity for hearing pursuant to section 189 of this Act, the Commission shall issue a site permit if it determines that such approval will not be inimical to the common defense and security or to the health and safety of the public.

"d. (1) A site permit issued by the Commission under this section may be referenced in an application for a construction permit or a combined construction permit and operating license which meets the conditions of the site permit and is filed within the period during which the site permit remains valid.

"(2) No less than twelve or more than thirty-six months prior to the expiration of the ten year period, the holder of the site permit may apply for a renewal of the site permit. The Commission shall renew the site permit for an additional period of time of not less than five nor more than ten years from the date of renewal unless it finds that the site will not comply with this Act or the Commission's regulations. If no application for a production or utilization facility is filed within the period of renewal, any outstanding fee for the re-

rewal application or issuance shall become due and payable by the applicant for the site permit.

"e. Approval of a site under this section shall not preclude its use as a site for an alternate or modified type of energy facility or for any other purpose. Other uses not considered in the approval may, however, affect the validity of the site permit or the conditions of its use for production or utilization facility siting as the Commission may determine.

"f. Following the issuance of a site permit under this section, and any subsequent Commission proceeding involving a site for which a site permit has been granted under this section, the Commission shall not modify any final determination on an issue that has been considered and decided in the site permit proceeding unless it determines, based on significant new information, that a modification is required to protect the public health and safety or the common defense and security and that the modification will substantially enhance the public health and safety or the common defense and security.".

APPROVAL OF DESIGNS

SEC. 104. The Atomic Energy Act of 1954, as amended, is amended by adding a new section 194 to read as follows:

"SEC. 194. APPROVAL OF DESIGNS.—

"a. The Commission is authorized and directed to establish procedures permitting the approval of standardized facility designs for thermal neutron power generation facilities for a period of ten years, notwithstanding the fact that no application for a construction permit or combined construction permit and operating license for such facility has been filed. The Commission may also consider, in accordance with its regulations, requests under this section for the approval of the design for any major subsystem which represents a discrete element of a thermal neutron power generation facility.

"b. Notwithstanding section 161 w. of this Act or the Independent Offices Appropriation Act of 1952, no application filing or issuance fees shall be required for an application for a design approval, an amendment, or a renewal of an approval of a facility design under this section. The Commission is authorized to allocate the costs that would otherwise have been defrayed by fees required of applicants under this section among applicants for permits or licenses which propose to use the approved standardized plant design in a manner that will assure full cost recovery by the Commission. If no application for construction of a facility is filed within the initial ten-year approval period, any outstanding fee shall become immediately due and payable by the applicant for the design approval.

"c. After considering all information submitted in the application, and after providing an opportunity for hearing pursuant to section 189 of this Act, the Commission shall issue an approval if it determines that such approval will not be inimical to the common defense and security or to the health and safety of the public.

"d. (1) Any approval issued by the Commission under this section may be referenced in an application for a construction permit, an operating license or a combined construction permit and operating license which meets the conditions of the approval and is filed within the period during which the approval remains valid.

"(2) No less than twelve or more than thirty-six months prior to the expiration of the ten year period, the holder of the approval may apply for a renewal of the approval. The Commission shall renew the approval for an additional period of time of not less than five nor more than ten years from the date of renewal unless it finds that the design will not comply with this Act or the Commission's regulations. If no application for construction of a facility is filed within the renewal period, any outstanding fee for the renewal or issuance shall become due and payable by the applicant for the design approval.

"e. Following the issuance of a design approval under this section, and in any subsequent Commission proceeding involving a facility design for which a design approval has been granted under this section, the Commission shall not modify any final determination of an issue that has been considered and decided in the design approval proceeding unless it determines, based on significant new information, that a modification is required to protect the public health and safety or the common defense and security and that the modification proposed will substantially enhance the public health and safety or the common defense and security by improving overall safety or security of facility operation.

"f. (1) The Commission shall approve an amendment to a design approval issued under this section upon application by the holder of the design approval if the Commission determines that the amendment will comply with this Act and the Commission's regulations.

"(2) Any amendment approved by the Commission under paragraph (1) shall apply to any application for a construction permit or combined construction permit and operating license referencing the design approval for which the amendment has been granted that is filed after the effective date of such amendment.

"(3) Any amendment approved by the Commission under paragraph (1) shall not apply to an application for a construction permit or combined construction permit and operating license referencing the design approval for which the amendment has been granted that is filed before the effective date of each amendment unless (A) the applicant requests that such amendment apply to the application, or (B) the requirements of subsection (e) are satisfied with respect to the amendment.

"g. Any application for a construction permit, an operating license or a combined construction permit and operating license or any amendment to such licenses referencing a design approval issued under this section may include a request for a variance from one or more elements of the design approval. Such requests shall be granted if the Commission determines that the variance will comply with this Act and the Commission's regulations. Any variance issued under this section shall be limited to the permit or license for which such variance has been requested.".

TITLE II—MISCELLANEOUS PROVISIONS

DEFINITIONS

SEC. 201. Section 11 of the Atomic Energy Act of 1954, as amended, is amended by adding new subsection dd. as follows:

"dd. 'Thermal neutron power generation facility' means a utilization facility which is designed to produce electrical energy and in which core power is designed to be produced predominantly by thermal neutron fission.".

SEC. 202. For the purposes of this Act the term "standardized design" means a design which the Commission determines is sufficiently detailed and complete to support licensing of a commercial production or utilization facility or approval of a major portion of such a facility when referenced in an application for a construction permit and operating license or a design approval and which is usable for a multiple number of units and/or at a multiple number of sites without reopening or repeating the review.

Sec. 203. a. The Commission shall, within one hundred and eighty days following the effective date of this section, propose regulations establishing procedures and criteria for implementing the provisions of sections 185 d., 193 f., and 194 e. of this Act for the control of the application of new requirements to any thermal neutron power generation facility licensed for construction or operation under this Act.

b. After the regulations referred to in subsection a. of this section become effective, no license, permit or approval granted under this Act for a thermal neutron power generation facility shall be modified except pursuant to such regulations.

TITLE III—CONFORMING AMENDMENTS

ANTITRUST PROVISIONS

Sec. 301. Subsection 105 c. of the Atomic Energy Act of 1954, as amended, is amended in the first sentence of paragraph (2) by inserting "and/" after the word "construct".

GENERAL PROVISIONS

Sec. 302. Section 161 o. of the Atomic Energy Act of 1954, as amended, is amended by inserting the words "or approvals authorized by section 193 and 194" after the number "104".

LICENSE APPLICATIONS

SEC. 303. Subsection 182 b. of the Atomic Energy Act of 1954, as amended, is amended to read as follows:

"b. The Advisory Committee on Reactor Safeguards shall review each application under section 103 or section 104 b. for a construction permit and/or an operating license for a facility; any application under section 104 c. for a construction permit and/or operating license for a testing facility; any application under section 104 a. or c. specifically referred to it by the Commission; any application for a site permit under section 193; any proposed approval for a facility design under section 194; any proposed authorization to commence operation under section 185 b.; and any application for an amendment to a construction permit or to an operating license under section 103 or 104 a., b., or c. or an amendment or renewal of a site permit under section 193 or an amendment or renewal of an approval for a facility design under section 194 specifically referred to it by the Commission, and shall submit a report thereon which shall be made a part of the record of the application and available to the public except to the extent that security classification prevents disclosure.".

REVOCATION

SEC. 304. Section 186 a. of the Atomic Energy Act of 1954, as amended, is amended by inserting the words "sections 182, 185, 193 and 194" after the words "required under".

TABLE OF CONTENTS

SEC. 305. The Table of Contents for the Atomic Energy Act of 1954, as amended, is amended by changing the title of section 185 to read "Construction Permits and Operating Licenses" and by adding the following after section 192:

"Sec. 193. Early Site Review.
"Sec. 194. Approval of Designs.".

TITLE IV—EFFECTIVE DATE

SEC. 401. All sections of this Act shall take effect as of the date of enactment, and shall apply to all proceedings pending as of the date of enactment or commenced on or after the date of enactment, in accordance with the terms of this Act.

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99TH CONGRESS
1ST SESSION

H. R. 2488

To encourage the standardization of nuclear powerplants, to improve the nuclear licensing and regulatory process, to amend the Atomic Energy Act of 1954, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

MAY 14, 1985

Mr. BROYHILL (by request) introduced the following bill; which was referred jointly to the Committees on Energy and Commerce and Interior and Insular Affairs

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A BILL

To encourage the standardization of nuclear powerplants, to improve the nuclear licensing and regulatory process, to amend the Atomic Energy Act of 1954, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Nuclear Facility Standardization Act of 1985".

FINDINGS AND PURPOSES

SEC. 2. (a) The Congress, recognizing that an effective and efficient licensing and regulatory process, for siting, construction, and operation of nuclear powerplants, which meets safety and environmental criteria is in the national interest, finds and declares that—

(1) interstate commerce is substantially affected by the siting, construction, and operation of nuclear powerplants;

(2) opportunity for meaningful public participation in the siting and licensing of nuclear powerplants should be assured;

(3) there is a need to encouarge the development and use of standardized nuclear powerplant designs because (A) these designs would benefit public health and safety by concentraing the resources of designers, engineers, and vendors on particular designs, by stimulating standardized programs of construction practice and quality assurance, by improving the training of personnel, and by fostering more effective maintenance and improved operations; and (B) the use of these designs would permit a more effective and efficient licensing and inspection process;

(4) the licensing process will be facilitated by selecting and approving a site for a nuclear powerplant in advance of a commitment to construct a facility at that site;

(5) the licensing and regulatory process will be facilitated if licensing decisions are made as early as pos-

sible in the process and if issues resolved in Nuclear Regulatory Commission proceedings are not reconsidered in the absence of a showing required by this Act and the regulations of the Nuclear Regulatory Commission;

(6) consistent with the adequate protection of the public health and safety and the common defense and security, the regulatory process should provide greater stability in licensing standards and criteria for approved designs of nuclear powerplants;

(7) consistent with the paramount responsibility of the Nuclear Regulatory Commission to protect the public health and safety, and recognizing that the elimination of all risk is an unattainable goal for any energy source, it is appropriate and in the public interest for the Nuclear Regulatory Commission to consider the economic consequences of its regulatory practices, including the cost of safety requirements; and

(8) the Nuclear Regulatory Commission should adopt regulations setting forth criteria to govern all additions, deletions, and modifications to its regulatory requirements; and these regulations should require a systematic, centralized, and documented review of the concerns that give rise to the proposed change, the improvement in safety that would result from adoption of

the proposed change, estimates of costs or other impact on potentially affected licenses and the public, taking into account, if facility-specific, the remaining life of the facility, and such other matters as the Commission determines to be necessary.

(b) The purposes of this Act are—

(1) to facilitate the development and use of standardized designs and the use of preapproved sites for nuclear powerplants;

(2) to provide for the issuance of a license to construct and operate a nuclear powerplant under conditions that enhance the protection of the public health and safety and are in accord with the common defense and security; and

(3) to improve the stability of licensing standards and criteria for nuclear powerplants and prior Commission licensing approvals.

TITLE I—LICENSING AND REGULATORY REFORM

APPROVAL OF STANDARDIZED DESIGNS

SEC. 101. The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) is amended by inserting after section 192 the following new section

"SEC. 193. APPROVAL OF STANDARDIZED DESIGNS.—

"a. The Commission shall establish procedures to permit the approval of standardized designs for a production or utilization facility to be licensed by the Commission and the approval of designs for any major subsystem of such a facility that represents a discrete element of the facility, as defined by the Commission, upon application by any person, after providing an opportunity for public hearing under section 189, notwithstanding the fact that an application for a construction permit or construction and operating license for the facility has not been filed.

"b. Notwithstanding section 161 w., or section 9701 of title 31, United States Code, the Commission shall not require an application filing or issuance fee for an application for approval or for an amendment or renewal of an approval under this section. The Commission may allocate the costs that would otherwise have been defrayed by fees required of applicants under this section among applicants for permits or licenses who propose to use the approved design. If there is no application for a construction permit or a construction and operating license within 10 years from the initial date of issuance of the approval, then the holder of the design approval shall pay the filing and issuance fees at the end of the 10-year period.

"c. (1) After considering the information submitted in the application, and after providing an opportunity for public hearing under section 189, the Commission shall issue an approval under this section if it determines that the design will comply with this Act, the rules and regulations of the Commission, and will not be inimical to the common defense and security or to the health and safety of the public.

"(2) Subject to section 187, a design approval may be amended or modified in a design amendment proceeding. In a design amendment proceeding, the Commission shall not admit an issue that has been considered and decided in the design approval proceeding or an earlier design amendment proceeding unless the Commission determines that there is a material issue in dispute that cannot be resolved with sufficient accuracy except in a hearing and—

"(A) the issue could not have been considered and decided in a proceeding for the issuance, modification, or amendment of a design approval; or

"(B) a showing has been made that there is a nonconformance with the design approval that could materially and adversely affect the safe operation of a facility using the design.

"(3) A change to the design approval required by the Commission shall not apply to a construction permit or construction and operating license incorporating the design approval unless (A) the licensee requests the change; or (B) the requirements of section 187 are satisfied with respect to the change.

"d. (1) An approval issued by the Commission under this section may be incorporated by reference in, and shall be conclusive with respect to, an application for a construction permit or a construction and operating license if the application meets the conditions of the approval and is filed within a period of 10 years from the date of issuance or renewal of the approval.

"(2)(A) Not less than 12 nor more than 18 months prior to the expiration of the 10-year period provided under paragraph (1), the holder of the design approval may apply for a renewal of the approval. Upon review, the Commission may renew the approval for additional 10-year periods from the date of renewal.

"(B) Upon application for renewal of an approval issued under subsection c., the Commission shall renew the approval unless it finds, based on significant new information relevant to the design, that the design will not comply with this Act or the Commission's rules and regulations for protection of the public health and safety and the common defense and security.

"e. (1) The Commission shall approve an amendment to a design approval issued under this section upon application by the holder of the design approval if the Commission determines that the amendment will comply with this Act and the Commission's regulations.

"(2) An amendment approved by the Commission under paragraph (1) shall apply to an application for a construction permit or construction and operating license incorporating the design approval for which the amendment has been granted that is filed after the effective date of the amendment.

"(3) An amendment approved by the Commission under paragraph (1) shall not apply to an application for a construction permit or construction and operating license incorporating the design approval for which the amendment has been granted that is filed before the effective date of the amendment unless (A) the applicant requests that the amendment apply to the application; or (B) the requirements of section 187 are satisfied with respect to the amendment.

"f. The holder of a permit, license, or approval may deviate from any aspect of the permit, license, or approval, without prior Commission approval unless the deviation involves a change in technical specifications incorporated in the permit, license, or approval or an unreviewed safety question. A deviation that involves changes to technical specifications or unreviewed safety problems shall be proposed to the Commission as an amendment to the permit, license, or approval.

"g. A final Commission determination on an application filed under subsection a. or d. of section 193 is a final order of the Commission for purposes of section 189 b.".

EARLY SITE APPROVAL

SEC. 102. The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) is amended by inserting after section 193, as inserted by this Act, the following new section:

"SEC. 194. EARLY SITE APPROVAL.—

"a. The Commission shall establish procedures to issue a site permit for approval of a site for one or more production or utilization facilities upon the application of any person, notwithstanding the fact that an application for a construction permit or a construction and operating license for the facility or facilities that has not been filed.

"b. (1) After considering all information submitted by an applicant, and after providing the opportunity for a public hearing under section 189, the Commission shall issue a site permit subject to conditions that it considers appropriate if it determines that the proposed site is suitable for the construction and operation of the facility or facilities described in the application and that use of the proposed site will not be inimical to the common defense and security or to the health and safety of the public.

"(2) In a subsequent Commission proceeding involving use of a site for which a site permit has been granted under this section, the Commission shall not admit an issue that has been considered and decided in the site permit proceeding unless the Commission determines that there is a material issue in dispute that cannot be resolved with sufficient accuracy except in a hearing and—

"(A) the issue could not have been considered and decided in a proceeding for the issuance, modification, or amendment of a site permit; or

"(B) a showing has been made that there is a nonconformance with the site permit that could materially and adversely affect the safe operation of a facility at the site.

"(3) A final Commission determination on an application filed under this section is a final order of the Commission for the purposes of section 189 b.

"c. (1) A site permit issued under this section may be incorporated by reference in, and shall be conclusive with respect to, an application for a construction permit or a construction and operating license if the application meets the conditions of the site permit and is filed within 10 years from the date of issuance or renewal of the site permit.

"(2)(A) Not less than 12 nor more than 18 months before the expiration of the 10-year period, a site permit holder may apply for a renewal of the site permit. Upon review, the Commission may renew a site permit for additional 10-year periods from the date of renewal.

"(B) Upon application for renewal of a site permit, the Commission shall renew the site permit unless it finds, based on significant new information that the site will not comply with this Act or the Commission's rules and regulations for protection of the public health and safety and the common defense and security.

"d. Approval of a site under this section does not preclude its approval for use as a site for an alternate or modified type of energy facility or for any other purpose.

"e. The Commission may issue a site permit with respect to limited aspects of the suitability of the site for its intended purpose, under rules and regulations the Commission considers appropriate.".

CONSTRUCTION PERMITS, OPERATING LICENSES, AND CONSTRUCTION AND OPERATING LICENSES

"SEC. 103. Section 185 of the Atomic Energy Act of 1954 (42 U.S.C. 2235) is amended to read as follows:

"SEC. 185. CONSTRUCTION PERMITS, OPERATING LICENSES, AND CONSTRUCTION AND OPERATING LICENSES.—

"a. An applicant for a license to construct or modify a production or utilization facility shall, if the application is consistent with the provisions of this Act, the rules and regulations of the Commission, and public health and safety and the common defense and security, be initially granted a construction permit, after the Commission has provided an opportunity for a public hearing under section 189. Upon the filing of additional information by the applicant needed to bring the original application up to date and after the Commission has provided an opportunity for a public hearing under section 189, the Commission shall issue an operating license to the applicant upon finding that the facility authorized has been constructed and will operate in conformity with the application as amended, the provisions of this Act, and the rules and regulations of the Commission. For all other purposes of this Act, a construction permit is a 'license'.

"b. (1) The Commission shall issue a construction and operating license to an applicant for a commercial production or utilization facility, after providing an opportunity for a public hearing under section 189, if the application contains sufficient information to enable the Commission to determine that there is reasonable assurance that the facility will be constructed and will operate in conformity with the application, the provisions of this Act, and the rules and regulations of the Commission. The Commission shall incorporate in the construction and operating license a phased-approval procedure for construction quality assurance. The Commission also shall incorporate in the construction and operating license the inspections, tests, analyses, and acceptance criteria therefor, that are necessary to provide reasonable assurance that the plant has been constructed and will operate in accordance with the license. The Commission procedure also may provide for inspections by the licensee's designated quality assurance inspectors, designated engineering and inspection representatives, and Commission inspectors.

"(2) Before a facility licensed under this subsection may begin operation, the utility shall notify the Commission of its readiness to operate the facility. Based on this notification, the Commission shall publish in the Federal Register a notice of intended operation of the facility, and shall provide a 30-day period during which any person may file a written objection to operation on the basis that the facility has not been constructed or will not operate in conformity with the license. An objection must set forth in reasonable detail the facts and arguments upon which the objection is based, and may be accompanied by a request for a hearing. If a hearing is requested, the Commission shall conduct a hearing if it determines that there is a material issue in dispute that cannot be resolved with sufficient accuracy except in a hearing and—

"(A) the issue was not and could not have been considered and decided in a proceeding for the issuance, modification, or amendment of a license, permit, or approval for that facility, its site, or design; or

"(B) a showing has been made that there is a nonconformance with the license that could materially and adversely affect the safe operation of the facility.

The Commission also shall determine whether the hearing must be commenced or completed before facility operation begins in order to provide reasonable assurance of the protection of the public health and safety and common defense and security.".

MODIFICATIONS

SEC. 104. Section 187 of the Atomic Energy Act of 1954 (42 U.S.C. 2237) is amended to read as follows:

"SEC. 187. MODIFICATIONS.—

"a. The Commission shall not require nor take an action to cause a change to a design approval, a site permit, a production or utilization facility for which a construction permit, operating license, or construction and operating license has been issued, the design of the facility, the procedures under which the facility is to be constructed or operated, or the organization required to construct or operate the facility, unless the Commission determines that the proposed change would result in a substantial improvement in overall safety of facility operation required under this Act and, for a production or utilization facility, is justified when taking account of the remaining life of the facility after considering the following factors:

"(1) the potential reduction in the risk to the public from the accidental off-site release of radioactive material;

"(2) the potential impact on radiological exposure of facility employees;

"(3) the installation and continuing costs associated with the proposed change, including the cost of construction delay or effect on continuity of service;

"(4) the potential safety impact of changes in plant or operational complexity including the effect on other proposed and existing requirements;

"(5) the estimated resource burden on the Commission associated with the proposed change and the availability of the resources;

"(6) the potential impact of differences in facility type, design, or age on the relevancy and practicality of the proposed change;

"(7) whether the proposed change is an interim or final requirement and, if interim, the justification for imposing the proposed change on an interim basis; and

"(8) such other matters as the Commission determines to be necessary.

"b. The Commission shall establish a centralized, systematic, and documented review process to evaluate and consider a proposed change. The Commission may make the proposed change effective, after its determination has been made, only by an amendment to the license or by issuing a rule, regulation, order, or amendment thereof. This section does not apply if the Commission determines that immediate action to impose a proposed change is necessary to protect the public health and safety or the common defense and security. If the Commission determines that immediate action is necessary, it shall document its determination after the fact.".

TITLE II—CONFORMING AMENDMENTS

ANTITRUST PROVISIONS

SEC. 201. The first sentence of section 105 c. (2) of the Atomic Energy Act of 1954 (42 U.S.C. 2135(c)(2)) is amended by striking out "a license to construct or operate" and inserting in lieu thereof "a license to construct, operate, or construct and operate".

LICENSE APPLICATION REVIEW

SEC. 202. Section 182 b. of the Atomic Energy Act of 1954 (42 U.S.C. 2232(b)) is amended to read as follows:

"b. The Advisory Committee on Reactor Safeguards shall review an application to grant, amend, or renew a license, construction permit, construction and operating license, or site permit. The Committee shall review each application for design approval, each proposed amendment or renewal of a design approval, and any application under section 103, 104, or 194 that the Commission refers to the Committee. The Committee shall submit a report to the Commission on each application, design approval or proposed amendment, or renewal of a rule that it reviews. The Committee decision

to review or fail to review an application or proposed amendment or renewal of a design approval and the Commission decision to refer or not refer an application to the Committee, is not subject to judicial review. Except to the extent that security classification prevents disclosure, any report required by this subsection shall be made part of the record of the application or rulemaking proceeding and available to the public.".

REVOCATION

SEC. 203. Section 186 a. of the Atomic Energy Act of 1954 (42 U.S.C. 2236(a)) is amended—

(1) by inserting "or site permit or design approval" after "license" each place it appears; and

(2) by inserting ", 193, or 194" after "182".

ATOMIC SAFETY AND LICENSING BOARD

SEC. 204. Section 191 a. of the Atomic Energy Act of 1954 (42 U.S.C. 2241(a)) is amended—

(1) by striking out "or" after "license" and inserting in lieu thereof a comma; and

(2) by inserting "site permit, or design approval" after "authorization".

TABLE OF CONTENTS

SEC. 205. The table of contents of the Atomic Energy Act of 1954 is amended—

(1) by striking out the item relating to section 185 and inserting in lieu thereof the following:

"Sec. 185. Construction Permits, Operating Licenses, and Construction and Operating Licenses.";

(2) by striking out the item relating to section 187 and inserting in lieu thereof the following:

"Sec. 187. Modifications."; and

(3) by adding after the item relating to section 191 the following:

"Sec. 193. Approval of Standardized Designs.
"Sec. 194. Early Site Approval.".

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Mr. Markey. Before debating the merits of these specific legislative proposals, I thought it would be useful to learn more about th problems for which these answers are searching. We are fortunat to have a very distinguished panel of witnesses from a variety o backgrounds, including representatives of a State public utilit commission, reactor vendors, utilities, architect engineers, constructors, financial institutions, the press, and knowledgeable observers.

We have asked the witnesses to tell us what they see as th major problems of the industry and in what order of importanc they could rank these difficulties. We have also asked them to tel us whether legislative remedies are appropriate. I think that it i important to remember that the NRC is only a part of the muc larger picture and that no one would benefit from our creating th illusion that changes at the NRC are a panacea.

I would like to have the prepared statement of our friend an colleague, the Honorable Richard Shelby, appear at this point i the record.

[The statement follows:]

STATEMENT OF REPRESENTATIVE RICHARD SHELBY

SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

JULY 25, 1985

MR. CHAIRMAN:

I COMMEND YOU FOR HOLDING THIS HEARING TODAY TO EXAMINE THE DIFFICULTIES FACED BY THE NUCLEAR POWER INDUSTRY. ONCE HAILED AS A CHEAP SOURCE OF ENERGY WHEN DEMAND FOR ELECTRICITY WAS RISING, THE GROWTH OF NUCLEAR POWER HAS BEEN BLOCKED BY A HOST OF FACTORS. HIGH INTEREST RATES AND THE ECONOMIC DOWNTURN DURING THE 1970's CAUSED ELECTRIC DEMAND TO SLACKEN AND RESULTED IN DRAMATIC COST INCREASES OF ALL CAPITAL INTENSIVE CONSTRUCTION PROJECTS -- PARTICULARLY NUCLEAR POWER PLANTS. MANAGEMENT DEFICIENCIES HAVE BEEN AN IMPORTANT FACTOR IN SOURING THE ORIGINAL PROMISE OF THE TECHNOLOGY. FURTHER, THE FEDERAL REGULATORY PROCESS HAS DAMPENED THE SAFE AND ECONOMIC OPERATION OF NUCLEAR POWER PLANTS.

I BELIEVE THAT THIS NATION CAN -- AND SHOULD -- BENEFIT FROM SAFE, INEXPENSIVE NUCLEAR POWER. OTHER NATIONS, SUCH AS FRANCE AND JAPAN, HAVE NUCLEAR PLANTS WHICH SUPPLY UPWARDS OF 30% OF THEIR ELECTRICITY DEMAND, WHILE THE U.S. NUCLEAR PORTION IS EXPECTED TO STAGNATE AT ONLY 20% OF TOTAL GENERATING CAPACITY.

WHEN DEALING WITH NUCLEAR POWER, SAFETY IS OUR HIGHEST PRIORITY. MY NEXT CONCERN IS PROVIDING CHEAP ENERGY SO THAT OUR NATION CAN EXERCISE ITS FULL ECONOMIC POTENTIAL. THE CURRENT STRUCTURE OF THE NUCLEAR REGULATORY PROCESS DOES NOT PROVIDE MAXIMUM BENEFITS FOR CONSUMERS IN TERMS OF SAFETY AND ECONOMY. TO REMEDY THIS SITUATION, I HAVE JOINED WITH CONGRESSMEN BROYHILL, MOORHEAD AND HALL OF THIS SUBCOMMITTEE IN INTRODUCING LEGISLATION REFORMING THE NUCLEAR LICENSING PROCESS. UNDER H.R. 1029, THE NUCLEAR REGULATORY COMMISSION WOULD BE DIRECTED TO DEVELOP AN APPROVED PROCESS FOR STANDARDIZED DESIGNS. THIS BILL WOULD CLEAR A STABLE PATH AWAY FROM OUR CURRENT PRACTICE OF CUSTOM BUILDING "ONE OF A KIND" PLANTS FOR WHICH SAFETY ISSUES CAN BE DIFFICULT TO RESOLVE AND SAFETY LESSONS DIFFICULT TO TRANSFER FROM ONE FACILITY TO ANOTHER. QUALITY ASSURANCE WILL ONLY BE ENHANCED THROUGH STANDARDIZATION.

REGULATORY STABILITY WOULD BE ENHANCED BY COMBINING CONSTRUCTION PERMITS AND OPERATING LICENSES FOR QUALIFIED UTILITIES THAT BUILD PRE-

APPROVED PLANTS. HEARINGS WOULD BE MANDATORY BEFORE CONSTRUCTION STARTS, SO THE PUBLIC IS GUARANTEED THE EARLIEST OPPORTUNITY TO PARTICIPATE IN THE APPLICATION PROCESS.

STANDARDIZATION ALSO MEANS THAT THE NRC WOULD BE APPROVING PLANT DESIGNS THAT ARE ALREADY SUBSTANTIALLY COMPLETE. TRADITIONALLY, APPLICANTS FOR PLANT CONSTRUCTION PERMITS, ANTICIPATING CONTINUAL CHANGES IN REGULATORY REQUIREMENTS, SUBMIT DESIGNS THAT ARE ONLY 15-20% COMPLETE; THIS "DESIGN-AS-YOU-GO" APPROACH LEADS TO SCHEDULE SLIPPAGE AND HIGHER COSTS. WE CAN CUT LEAD TIMES AND PRICE TAGS THROUGH PRE-APPROVED STANDARDIZED DESIGNS.

IN ALABAMA, FIVE NUCLEAR OPERATING UNITS GENERALLY ACCOUNT FOR 20% OF THE STATE'S ENERGY CAPACITY, SUPPLYING OVER 5,000 MEGAWATTS OF POWER. HOWEVER, RECENTLY, THREE UNITS IN NORTH ALABAMA HAVE BEEN CLOSED BY THE MANAGEMENT FOLLOWING REPEATED PROBLEMS WITH FEDERAL SAFETY REGULATIONS. I AM PARTICULARLY INTERESTED IN WHAT THE WITNESSES HERE TODAY HAVE TO SAY ABOUT HOW PLANT MANAGEMENT -- AND THE REGULATORS -- CAN BOTH WORK TOWARD A SAFE AND ECONOMIC NUCLEAR POWER SUPPLY FOR OUR NATION'S ENERGY NEEDS.

THANK YOU, MR. CHAIRMAN.

Mr. Markey. I will now introduce the ranking minority membe the gentleman from California, Mr. Moorhead.

Mr. Moorhead. Thank you, Mr. Chairman. I want to welcon the witnesses to today's hearing on what I believe has become a s rious national problem. Some claim that nuclear problem is r longer a viable option to our Nation's energy future. We cann afford to have this claim become fact.

I want to commend the chairman for his commitment to addre the regulatory and licensing problems facing the nuclear indust and for scheduling this hearing to establish the sound legislati record upon which the subcommittee can proceed in its conside ation of licensing reform proposals.

I think today's hearing will demonstrate that a consensus has ready developed in support of legislative reforms designed to fost standardized designs and regulatory stability. Virtually everyo agrees with the concept of standardized designs.

Standardized designs will emphasize safety by concentrating t resources of designers, engineers and vendors on a few improv designs, and by stimulating standardized programs of constructi practice and quality assurance. It will also facilitate a more rea sharing of construction and operating experience, which will turn promote improved performance.

To the extent regulatory stability is fostered, the utilities w benefit by being able to make reasoned decisions concerning the ability of nuclear power.

For these reasons I joined my distinguished friend from Nor Carolina, Mr. James Broyhill, and a bipartisan group of colleagu in introducing H.R. 1029, the Nuclear Power Plant Standardizati Act of 1985. H.R. 1029 has now attracted more than 60 cosponso and I urge my colleagues to act expeditiously on this legislation would like to have Congressman Broyhill's statement appear this point in the record.

[The prepared statement of Congressman Broyhill follows:]

STATEMENT OF THE HONORABLE JAMES T. BROYHILL
BEFORE THE SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

JULY 25, 1985

HEARING ON NUCLEAR LICENSING AND REGULATORY REFORM

MR. CHAIRMAN, NUCLEAR POWER IS AN INDISPENSABLE ENERGY RESOURCE FOR AMERICA. THERE ARE ALMOST NINETY PLANTS CURRENTLY IN COMMERCIAL OPERATION AND THIRTY-FOUR MORE PLANTS UNDER CONSTRUCTION. JUST THIS YEAR, NUCLEAR POWER BECAME THE SECOND LARGEST SOURCE FOR ELECTRICAL ENERGY IN AMERICA -- AND NUCLEAR POWER IS SUPPLYING CHEAP, RELIABLE, SAFE AND ENVIRONMENTALLY SOUND POWER THROUGHOUT THE COUNTRY.

YET NUCLEAR POWER HAS LOST MUCH OF ITS ATTRACTIVENESS. THE TIME NECESSARY TO BUILD AND LICENSE A NUCLEAR POWER PLANT HAS DOUBLED OVER THE LAST DECADE AND NOW EXCEEDS TWELVE YEARS -- WELL BEYOND THE PERIOD IN WHICH ELECTRIC DEMAND AND CONSTRUCTION COSTS CAN BE PREDICTED WITH ANY DEGREE OF ACCURACY.

THE NUCLEAR INDUSTRY'S CURRENT PROBLEMS ARE NOT SOLELY ATTRIBUTABLE TO THE FEDERAL GOVERNMENT'S REGULATION OF NUCLEAR POWER. THE ECONOMIC SLOWDOWN AND HIGH INTEREST RATES DURING THE 1970's DAMPENED THE GROWTH OF ELECTRIC DEMAND AND DRAMATICALLY INCREASED THE COST OF ALL CAPITAL INTENSIVE CONSTRUCTION PROJECTS -- PARTICULARLY NUCLEAR POWER PLANTS. MANAGEMENT DEFICIENCIES HAVE ALSO HURT THE INDUSTRY.

BUT TO ITS CREDIT, THE NUCLEAR INDUSTRY HAS RECOGNIZED THAT MUCH OF THE BURDEN OF REFORM RESTS WITH IT. THE NUCLEAR INDUSTRY HAS TAKEN AGGRESSIVE ACTION TO UPGRADE MANAGEMENT, QUALITY ASSURANCE, OPERATOR TRAINING AND THE OTHER ELEMENTS THE NUCLEAR OPERATION.

BUT IF THE NATION IS TO REALIZE THE FULL BENEFITS NUCLEAR POWER AND THE INDUSTRY'S SELF-INITIATED REFORMS, CONGRESS MUST SHOULDER ITS RESPONSIBILITY AND REFORM THE NUCLEAR REGULATORY AND LICENSING PROCESS. AS REPORTED IN A RECENT STUDY BY THE EDISON ELECTRIC INSTITUTE, NO UTILITY WOU CONSIDER ORDERING A NEW NUCLEAR PLANT UNDER THE CURRENT REGUL REGIME.

THE CURRENT PROCESS FOR REGULATING NUCLEAR POWER DO NOT WORK IN THE BEST INTERESTS OF EITHER THE PUBLIC OR THE INDUSTRY. THE INDUSTRY'S AND ITS REGULATOR'S RESOURCES ARE DIVERTED FROM IMPORTANT SAFETY RELATED WORK. THERE IS AN UNCERTAIN AND UNSTABLE REGULATORY ENVIRONMENT. THE LICENSING PROCESS FAILS TO MAXIMIZE THE EFFECTIVENESS OF PUBLIC PARTICIP NEW OR MODIFIED SAFETY REQUIREMENTS ARE IMPOSED WITHOUT REGARD TO COST AND THE IMPACT ON OVERALL SAFETY.

IN ADDITION TO UNDERMINING UTILITIES' FAITH IN THE REGULATORY PROCESS, REGULATORY UNCERTAINTY RESULTS IN COMPLETED PLANTS BEING SIGNIFICANTLY DIFFERENT AND MUCH MORE COSTLY THAN ORIGINALLY ENVISIONED. FURTHERMORE, THE COSTS OF AN UNSTABLE REGULATORY ENVIRONMENT ARE NOT LIMITED TO STRICTLY MONETARY TERMS. MR. JAMES TOURTELLOTTE, CHAIRMAN OF THE COMMISSION'S

OWN REGULATORY REFORM TASK FORCE, EXPLAINED IN HIS REPORT THIS SPRING THAT AN UNSTABLE REGULATORY ENVIRONMENT HAS SAFETY, AS WELL AS COST, IMPLICATIONS.

CLEARLY, THE PUBLIC WILL BENEFIT FROM REFORMS THAT ENCOURAGE STANDARDIZATION, A MORE EFFECTIVE APPLICATION OF INDUSTRY AND NRC RESOURCES, MORE MEANINGFUL PUBLIC PARTICIPATION AND THE REDUCTION OF UNNECESSARY COSTS.

THE MORE THAN SIXTY COSPONSORS OF THE "NUCLEAR POWERPLANT STANDARDIZATION ACT" ARE NOT ALONE IN RECOGNIZING THE NEED FOR NUCLEAR LICENSING REFORM. THE ADMINISTRATION AND THE NRC HAVE BOTH SUBMITTED LICENSING REFORM PACKAGES TO CONGRESS. OVER IN THE SENATE, SENATOR SIMPSON, CHAIRMAN OF THE SUBCOMMITTEE ON NUCLEAR REGULATION, HAS LONG SUPPORTED NUCLEAR LICENSING REFORM AND HAS ASSURED ME THAT SUCH REFORM WILL BE A TOP PRIORITY FOR HIS SUBCOMMITTEE THIS CONGRESS.

MR. CHAIRMAN, ALL OF THESE INITIATIVES ARE DESIGNED TO ACHIEVE THE SAME GOAL -- THE ENACTMENT OF LEGISLATION TO ENCOURAGE REGULATORY STABILITY AND THE DEVELOPMENT AND USE OF STANDARDIZED NUCLEAR POWERPLANT DESIGNS. THE SIMILARITIES BETWEEN THE PROPOSALS ARE STRIKING, AND DOCUMENT THAT A CONSENSUS HAS NOW DEVELOPED AS TO THE FIRST STEPS LEGISLATIVE REFORM SHOULD TAKE.

A CONGRESSIONAL MANDATE FOR CHANGE IS OBVIOUSLY A PREREQUISITE FOR REGULATORY REFORM. THE NUCLEAR POWERPLANT STANDARDIZATION ACT WILL NOT SOLVE ALL OF THE PROBLEMS IDENTIFIED IN THESE REPORTS. THERE ARE OTHER ISSUES, SUCH AS MANAGEMENT AT THE NRC AND FINANCING, WHICH ARE ALSO IMPORTANT AND ON WHICH THERE MAY NOT YET BE A CONSENSUS AS TO THE APPROPRIATE REMEDY. BUT CONGRESS CANNOT DELAY ENACTING THE MEASURES WHICH EVERYONE AGREES ARE NECESSARY.

ELECTRICITY DEMAND GREW AT A PACE THAT EXCEEDED ALMOST EVERYONE'S EXPECTATIONS IN 1984. EXCESS CAPACITY THAT EXISTS TODAY IN CERTAIN REGIONS OF THE COUNTRY MAY WELL VANISH IN THE NEXT FEW YEARS NOW THAT OUR ECONOMY HAS RETURNED TO A HEALTHY GROWTH RATE. REALISTICALLY THERE ARE ONLY TWO FUELS AVAILABLE TO MEET OUR FUTURE ELECTRIC NEEDS -- COAL AND URANIUM. IF WE ARE TO AVOID DESTROYING THE NUCLEAR OPTION, HOWEVER, THE FEDERAL GOVERNMENT MUST ACT SOON AND MATCH INDUSTRY'S REFORM EFFORTS. WE MUST PUT A SOUND SYSTEM FOR REGULATING NUCLEAR POWER INTO PLACE. I LOOK FORWARD TO WORKING WITH THE CHAIRMAN AND THE OTHER MEMBERS OF THE SUBCOMMITTEE ON THIS CRUCIAL ISSUE, AND CALL UPON MY COLLEAGUES TO JOIN WITH ME TO FASHION A SOLUTION TO THE PROBLEMS PLAGUING THE REGULATION OF NUCLEAR POWER.

THANK YOU.

Mr. **Moorhead**. The need for this legislation has most recently been documented in two reports. The first was prepared by Mr. James Tourtellotte, chairman of the NRC Regulatory Reform Task Force. The second is the report on nuclear power by the Edison Electric Institute.

I would ask unanimous consent to include both these reports in the hearing record.

Mr. **Markey**. Without objection they will be included.

[The documents appear on pages 411 and 450 respectively.]

Mr. **Moorhead**. And I would also ask to include the written testimony of Stone and Webster in the record.

Mr. **Markey**. It will also, without objection be included in the record.

[Statement of James T. Ramey follows:]

STATEMENT OF
JAMES T. RAMEY, VICE PRESIDENT
STONE & WEBSTER ENGINEERING CORPORATION
FOR THE RECORD

SUBCOMMITTEE ON ENERGY CONSERVATION & POWER
COMMITTEE ON ENERGY & COMMERCE
UNITED STATES HOUSE OF REPRESENTATIVES
JULY 25, 1985

Mr. Chairman and Members of the Subcommittee:

My name is James T. Ramey. I am Vice President and Senior Energy Advisor to the Chairman of the Board of Directors of Stone & Webster Engineering Corporation. I have previously testified before the Congress on these issues before us today beginning in 1971, with the last time being before the House Subcommittee on Energy and the Environment, Committee on Interior and Insular Affairs in June, 1983. I also have had the privilege of having served as a Commissioner of the Atomic Energy Commission for about eleven years where I was the "lead" Commissioner for licensing and regulation issues.

I appreciate your invitation of June 20 to appear today to express our views, as an engineer-constructor of nuclear power plants, on the need for legislation which encourages standardization as well as to provide comments on the merits of the NRC and DOE legislative proposals. At the present time, there is pending before this committee, S. 836, the "Nuclear Power Plant Licensing and Standardization Act of 1985". As your letter indicates, the Department of Energy has transmitted proposed standardization legislation to the Congress, and Congressman Broyhill and a number of co-sponsors have introduced H.R. 1029 in the House.

We are firmly convinced standardization and related measures will assure adequate safety while creating an environment of predictability and reasonable certainty as to the licensing process. Such improvement is essential to a climate in which utilities will once again consider ordering nuclear power plants. Because about half the cost of a plant is a function of the time involved -- as reflected in interest and inflation -- it is imperative to bring greater stability to the overall process.

The current statutory licensing procedures were developed when the nuclear industry was getting started. This process has proven to be cumbersome, lacking in stability, and unnecessarily costly to the consumer, the regulators, and the industry. In this regard, the present licensing process diverts scarce regulatory and industry resources from uses that would better serve safety aims. Thus, standardization is greatly needed to combat inefficiencies in the current regulatory regime.

It has been proposed, and it is certainly arguable as a legal matter, that many of the concepts of standardization could be achieved through administrative action. It is our position that the policy and program on standardization must be established by legislation and implemented by administrative action if it is to be effective.

The key to certainty and stability in the nuclear licensing process is discipline in all phases of the process and on the part of all participants. Legislation is necessary to provide this discipline and to provide for the long-term policies which would transcend individual philosophies within NRC and the nuclear industry. Administrative reforms alone, involving the exercise of discretion by NRC, have proved to be insufficient. It is important that Congress clarify its position and take a leadership role to provide the legislation required to stabilize nuclear regulation and licensing. In simplistic terms, Congress must express its intent and provide the legislative impetus to make it happen.

Stone & Webster Engineering Corporation is a pioneer in nuclear plant standardization. We began our efforts on standardization in the late 1960s and have participated in the NRC standardization program since its inception in 1972. We were the first engineer-constructor to receive approval from the NRC for a "reference" balance-of-plant design, in May, 1976, matching a specific nuclear steam supply system. This was, of course, a Preliminary Design Approval.

Attaining our first Preliminary Design Approval was the result of a commitment of hundreds of our engineering and design personnel over a decade to a project dedicated solely to this reference design. This effort included not only development of engineering, but also construction planning to ensure that the design was as efficient to construct as possible.

Since receipt of the Preliminary Design Approval in May, 1976, we have had our balance of plant design approved relative to two additional reference nuclear steam supply system designs and had requested an approval for a fourth. These approvals required additional engineering of our reference design to provide the proper match with the particular nuclear steam supply system. Even with this additional engineering, the vast majority of the balance of plant was maintained as a single standard design. Our reference design was used in the first application, submitted by New York State Electric & Gas Corporation and Long Island Lighting Company, for a construction permit which incorporated both previously approved nuclear steam supply system and balance of plant reference designs. The application was, unfortunately, withdrawn by the utility due to reduced power demand.

We also have been active in other types of standardization programs such as the NRC Topical Report Program. We have received NRC approval for topical reports on subsystems for the reference nuclear power plant, on an independent spent fuel storage facility, and on various software. In addition, we were the first engineer-constructor to receive, in 1974, NRC approval for a standard nuclear quality assurance program. We also have standardized our construction methods and procedures, such as material controls, handling and storage, steel erection, and concrete placement.

We believe standardization can contribute positively in a number of ways. Repeated design, construction, and manufacturing techniques and procedures permit increased efficiency, resulting in higher quality, and that translates to greater safety. Another significant advantage of standardization is the reduction in the number of plant design variations with which plant operators and operational support teams would have to be familiar. This would ensure increased operator capability. Standardization will permit greater concentration of specialized talents on more detailed safety considerations and front-end engineering which is often preferable to in-process development as it occurs without the pressure of a plant completion schedule. Because of favorable cost impact, the additional benefit of lower power costs to the public is also achieved by standardization.

An appropriate base for standardization to build upon is available in today's plants. The level of safety of these plants is high. The extreme level of conservatism present is evidenced in the available documentation that shows the amount of radioactivity assumed to be released from the plant in a postulated accident - the nuclear source term - used in the design of these plants is considerably overstated.

The keys to realizing the above benefits and, from our perspective as an engineer-constructor, perhaps the most significant aspects of any new legislation are two-fold: A provision for approval of designs for major portions of a plant prior to the application for a license to build and operate a specific plant, with its encouragement of standardization; and a single-stage licensing process. These provisions ensure early and knowledgeable public participation in the licensing process for a particular plant and for a pre-approved design. This is the appropriate time for effective public participation, because all the information necessary to make final determinations on plant safety is available. It is also a time before significant resources have been expended on plant construction.

We endorse provision of early design approval, independent of site or license application. Under such an approach, the developer of a design for a nuclear plant or major portion of a plant would submit a Safety Analysis Report with an application for a Design Approval. The applicant could be either a reactor manufacturer, an engineer-constructor, a utility, or any combination of these. The application could describe a nuclear steam supply system or a balance of plant, as was the practice under the reference system option of existing NRC standardization policy. An entire plant could also be described as was done under the manufacturing license, duplication, and replication options of this NRC standardization policy.

We endorse the use of a balance of plant matched with a nuclear steam supply system, because it is consistent with the well-tested and long-standing practices in the nuclear industry. Also, the use of this approach will ensure that the significant amount of expertise now within existing engineer-constructors and reactor manufacturers would not be lost and there would be no loss of continuity in maintaining safe operation of plant designs already in use.

The many benefits of standardization can best be realized through use by all of the qualified participants in the nuclear business. Legislation, therefore, should direct rather than merely authorize the NRC to establish procedures for approval of both facility and major subsystem designs. This will ensure establishment of procedures to provide maximum flexibility and use of pre-approved designs. We believe that a true single-stage licensing process is both feasible and realistic. A single hearing in conjunction with the issuance of a combined construction and operating license can properly treat all the issues not covered by any pre-approved designs and sites being used in the application. Implementation of the design and the software (e.g., quality assurance programs and emergency plans) is audited during construction and tests or practice exercises. A single stage licensing process would not result in a reduction in safety or meanful public participation because the NRC currently has authority to order a hearing at any time it deems necessary to protect public health and safety and to prevent operation of any facility not in compliance with provisions of a license.

An important aspect of the single-stage licensing process is determining the extent and level of design information necessary for the NRC to determine that a plant is designed, and can be constructed and operated, in conformity with the provisions of the Atomic Energy Act and the NRC's rules and regulations. We believe an in-between level of design information, i.e., a considerably greater level of design detail in many areas than a current Preliminary Safety Analysis Report but less than a current Final Safety Analysis Report, would be sufficient and reasonable for the NRC to reach a conclusive safety determination. The detailed design documents i.e. calculations such as cable tray loads etc. and drawings such as pipe supports are used primarily in the construction phase rather than the initial phase. They also must be checked after procurement of hardware. This design level requires criteria and standard specification and design methods which are verifiable by the NRC, as necessary, during procurement and implementation of the design.

We further endorse the concept of an Early Site Approval process. We suggest that legislation state clearly that an applicant may describe, in total or in part, an acceptable environmental impact for a particular site , based on an envelope of parameters, without the necessity of specifying the plant size. This would provide the applicant with the flexibility of constructing one or more facilities on a particular site so long as the cumulative environmental impacts associated with those facilities remain within the previously approved acceptable site related impacts envelope.

Nuclear plant standardization must carry with it the discipline of regulatory stability. The NRC staff has ignored the current backfit rule by not showing that imposed backfits meet the criteria stated in the rule. Administrative actions that change regulations, practice, and policy one month can change them back again in the succeeding months. There is a pronounced need for legislative requirements which are not subject to change administratively and that provide the stability necessary for nuclear power to serve the public needs safely.

It is in the public interest to weigh the enhancement in the overall level of health and safety to the public against the cost to the public. This balancing will greatly stabilize design and site approvals and enhance standardization. It will also stabilize the entire industry, from plants under construction to plants in operation. Proper backfit requirements are basic to the continued viability of the nuclear industry and should be applied throughout all phases of design, construction, operation, and regulation.

I understand that you have before you the recent report from the Congressional Research Service which compares the principal legislative proposals with each other and their progression from those before the last Congress. I have no intention of reiterating the observations in that report, but I do note that we concur in the distinctions observed. May it suffice for me to observe that the legislation submitted by the NRC, S. 836, pending before this committee, goes a long way toward achieving the objectives I have described. The Department of Energy recommended approach goes further and, we believe, is more comprehensive.

I believe that the standardization process would be substantially enhanced by enactment of any one of the proposals with maximum benefit coming from a combination of the best features of each. For instance, we endorse the "conclusiveness" of design approvals provided by the DOE version as it would prevent repetitive litigation. Additionally, the criteria to be applied in approving changes to such design approvals are more appropriate in the DOE bill in that they are more consistent with the principles of standardization. Similar provisions are accorded the approval of a site by the DOE bill only.

With respect to the combined construction and operating license, the DOE and NRC are in substantial accord. One positive aspect of the DOE version not presented by the NRC is the phased approval of construction quality assurance which we would recommend. This approval should be part of the NRC's inspection activities and should not involve additional submittals. This phased approval, coupled with the availability of results of the inspections, tests and analyses specified in the license, will provide assurance of conformance of the plant to the license. This reinforces our previous statement that a legislated second hearing opportunity is unnecessary for a combined construction and operating license.

Perhaps the area of most distinction between the bills is the so-called "backfit" provisions. We endorse the approach recommended by the DOE as the one providing the greatest guidance and certainty of result. We also particularly agree with inclusion of a balancing of costs and benefits in this evaluation.

In summary, we believe the existing process for licensing and regulation of nuclear power plants is neither predictable nor stable. Any proposed legislation should provide for standardization available for use by qualified organizations for major portions of a plant and should seek to improve the opportunity for early public participation in the process while minimizing the potential for abuse of the process by those bent only on delay. If these improvements are adopted, it is our view that the quality of NRC decisions in the resolution of health, safety, and environmental issues is likely to be further enhanced by passage of such legislation.

In conclusion, I would point out that the first comprehensive licensing reform legislation was proposed by the Atomic Energy Commission in 1971. The Calvert Cliffs decision seemed to get in the way of serious consideration of that legislation in 1971 and 1972. In 1973 and 1974, the Price-Anderson Act extension took priority over licensing reform. And in 1978, the Carter Administration did not seem able to generate much enthusiasm for reform. In the past few years, the nuclear high level waste legislation received priority. I would hope that consideration of Price-Anderson extension, important as it is, will not preempt consideration of standardization and licensing improvement again this year as well.

The electrical energy needs of our country are critical. Nuclear power can play an important role in meeting these needs safely, economically and on an environmentally sound basis. We are convinced that efforts to stabilize and bring predictability to the licensing process will advance the realization of that goal. We support the need for legislation and urge the Congress to act on these legislative proposals before you.

This concludes my remarks Mr. Chairman. I would be happy to respond to your questions.

Mr. Moorhead. Thank you, Mr. Chairman.

Mr. Markey. Thank you, our first panel—are there any other members who wish to make opening statements?

Mr. Bryant. No.

Mr. Markey. Our first panel consists of Mr. Sol Burstein, the vice chairman of the board of the Wisconsin Electric Power Co.; Mr. R.P. McDonald, senior vice president Alabama Power Co.; Mr. Joseph Swidler, Esquire, Swidler, Berlin & Strelow, chartered from Washington, DC; the Honorable Edwyna Anderson, commissioner of the Michigan Public Service Commission; Mr. Eugene W. Meyer, vice president and director Kidder, Peabody; and Ellyn Weiss, Esq. from Harmon, Weiss & Jordan.

We will begin the opening statements with Ms. Anderson. We will ask that all of you keep your statements down to 5 minutes. It will be a rigidly enforced rule, and if the time runs out on you, you will have lost your opportunity to make your statement. So please, try to keep your statements within that 5-minute limit.

Ms. Anderson, could you please begin?

STATEMENTS OF EDWYNA ANDERSON, COMMISSIONER, MICHIGAN PUBLIC SERVICE COMMISSION; SOL BURSTEIN, VICE CHAIRMAN, WISCONSIN ELECTRIC POWER CO.; ROBERT P. McDONALD, SENIOR VICE PRESIDENT, ALABAMA POWER CO.; ELLYN R. WEISS, GENERAL COUNSEL, UNION OF CONCERNED SCIENTISTS; AND JOSEPH C. SWIDLER, ESQ., SWIDLER, BERLIN & STRELOW, CHARTERED

STATEMENT OF EDWYNA ANDERSON

Ms. Anderson. Thank you very much, Mr. Chairman. I'm honored to be invited here today to present the views of my commission and my colleagues, Commissioners Eric J. Schneidewind and Matthew McLogan on problems facing the nuclear industry at a time when the Congress is contemplating at least three initiatives that in the views of their authors will revive this important component of our Nation's electric system.

With me today are my staff counsel, George Daniels and Michigan Public Service Commission staff member research specialist, Michael Fielek.

We at the Michigan Public Service Commission have dealt with the benefits of nuclear power in the past having had a plant in operation since 1962 when the Big Rock Point station began production. Since that time we have added nearly another 3,000 megawatts more of nuclear generation with another 1,000 coming online by the end of 1985.

The commission now, however, has before it the task of dealing with the downside of the industry, including $4 billion worth of canceled plants and substantial cost overruns of facilities soon to come online.

Since we as a commission are vested with the responsibility for ruling on the distribution of these costs, I'm not able to speak today to the specifics of Michigan's current nuclear problems and projects, but I would like to share some of our views on the subject in general.

There are two very central conclusions we wish to draw from ou exploration and experience. The first is, that despite all the acknowledged changes, interruptions and reconsiderations in nuclea power plant construction, there are, indeed, well-managed plants whose overall costs are on an industrywide basis within reasonable limits. That suggests that the job can be done properly within or despite the current regulatory framework.

Second is that there are gaps in regulation of nuclear plant construction that should be closed. They occur among and between safety considerations that influence design and redesign, the response of utility management in controlling the construction by its contractors, and the ultimate act by utility commissions in determining legitimate construction costs versus imprudent cost overruns.

You are well aware of the very expensive and troubled history when it comes to construction. As an industry, nuclear unit construction completion costs have soared to levels never imagined by anyone in the 1960's and the early 1970's.

The even more astounding fact is that despite massive infusions of capital, many plants will never provide the electricity to illuminate so much as one light bulb. This clearly is a tragedy, irrespective of how anyone feels about the "morality" of nuclear power.

In assessing the U.S. nuclear industry, one must carefully evaluate the effects of regulation, both State and Federal, the construction industry, and utility management. Although all have contributed to the industry's decline, we focus today upon utility management.

It is our belief that examination of the nuclear power industry's problem must begin through internal examination of utility management decisionmaking. Our commission has conducted a staff study, a detailed study that shows the historic costs of nuclear units in the United States. The purpose was to review characteristics of each of the nuclear projects, and through a systematic process of analysis establish a range of construction costs so as to allow a realistic comparison of individual units with the industry as a whole.

The study involved 140 nuclear units, both operating and under construction, and financial data was accumulated for a period of 1968 through 1982. The result is one of the most complete collections of information of this type available, one that has been used by several State regulatory commission investigators to investigate and analyze their own construction projects.

Although this study has many findings, one clear fact is established, that after adjusting for inflation, regional cost differences and timing, some units were substantially more expensive than others, even though they were constructed under the same regulatory oversight.

Thus regulation cannot be labeled as the only culprit in the nuclear industry's current dilemma.

We contend that project management plays the most crucial role in the development of a successful nuclear facility, in spite of what have been referred to as regulatory hurdles. As the challenges grew, and the complexity of the task increased, utility managers—

not all, but far too many—repeatedly continued to underestimate the challenge.

For example, between June 1974 and June 1977, 14 nuclear projects were authorized by the NRC. Completed costs of these 14 plants range from a low of $2 billion to a high of $5.5 billion for units of roughly the same size and type.

Mr. MARKEY. The lady's time has expired. Mr. Burstein?

[Statement of Ms. Anderson follows:]

United States
House of Representatives
Committee on Energy and Commerce
Energy Conservation and Power Subcommittee

Summary of Testimony
By
Edwyna G. Anderson, Commissioner
Michigan Public Service Commission
On
What's Wrong with the Nuclear Industry?

Significant cost differentials between nuclear units around the country suggest one major problem in the nuclear industry: Utility management. Plants started at the same time and constructed under the same regulations have final costs that are billions of dollars apart. Because of this fact, utility management must be improved in order to benefit from any of the proposed regulatory changes or the nuclear industry will continue its decline.

Laws alone cannot cure the ills of an industry that must set about to clean up its own act.

UNITED STATES
HOUSE OF REPRESENTATIVES
COMMITTEE ON ENERGY AND COMMERCE
ENERGY CONSERVATION AND POWER SUBCOMMITTEE

TESTIMONY BY
EDWYNA G. ANDERSON, COMMISSIONER
MICHIGAN PUBLIC SERVICE COMMISSION

ON

WHAT'S WRONG WITH THE NUCLEAR INDUSTRY?

JULY 25, 1985

Mr. Chairman and members of the Subcommittee,

I am Edwyna G. Anderson, Commissioner of the Michigan Public Servi Commission (MPSC). I am honored to be invited to present the views of my Commission and my colleagues, Chairman Eric J. Schneidewind and Commissioner Matthew E. McLogan, on the problems facing the nuclear industry at a time when the Congress is contemplating at least three initiatives that, in the views of their authors, will revive this impo component of our nation's electric system. With me today are my Staff Counsel, George F. Daniels, and MPSC Staff member, Research Specialist Michael A. Fielek.

The Michigan Public Service Commission has dealt with the benefits of nuclear power in the past, having had such a plant in operation since 1962 when the Big Rock Point station began production. Since that time, Michigan utilities have added nearly 3000 megawatts more of nuclear generation, with another 1000 coming on line by the end of 1985. The Commission now has before it the task of dealing with the downside of the industry including $4 billion worth of cancelled plants and substantial cost overruns of facilities soon to come on line. Since we as a Commission are vested with the responsibility for ruling on the distribution of these costs, I am not able to speak today to the specifics of Michigan's current nuclear projects, but would like to share some of our views on the subject in general.

There are two very central conclusions we wish to draw from our exploration and experience. The first is that, despite all the acknowledged changes, interruptions and reconsiderations in nuclear power plant construction, there are well-managed plants whose overall costs are, on an industry-wide basis, within reasonable limits. That suggests that the job can be done properly within or despite the current regulatory framework.

Second is that there are gaps in regulation of nuclear plant construction that should be closed. They occur among and between safety considerations that influence design and redesign, the response of utility management in controlling the construction by its contractors, and the ultimate act by utility commissions in determining legitimate construction costs versus imprudent cost overruns.

You are all well aware of the troubled, expensive and varied construction history in this industry. As an industry, nuclear unit construction completion costs have soared to levels never imagined by anyone in the 1960s and early '70s. The even more astounding fact is that despite massive infusions of capital, many plants will never provide the electricity to illuminate one light bulb. This clearly is a tragedy irrespective of how anyone feels about the "morality" of nuclear power.

In assessing the U.S. nuclear industry, one must carefully evaluate the effects of regulation (both federal and state), the construction industry, and utility management. Although all have contributed to the industry decline, we focus today upon the role of utility management.

It is our belief that examination of the nuclear power industry's problems must begin through internal examination of utility management decisionmaking. Our Commission Staff study concerning this subject should raise some serious questions as to reasons for the wide variation in power plant cost and performance resulting from management decisions made under comparable regulatory and economic circumstances.

In 1984, the Michigan Public Service Commission Staff performed a detailed study of the historic costs of nuclear units in the United States. The purpose was to review characteristics of each of the nuclear projects and through a systematic process of analysis establish a range of construction costs so as to allow a realistic comparison of individual units with the industry as a whole.

The study involved the establishment of a comprehensive data base for approximately 140 nuclear units both operating and under construction. Financial data regarding annual construction expenditures was collected and subsequently verified for the period of 1968 through 1982. The result is one of the most complete collections of information of this type available, one that has been used by several state regulatory commission investigators to analyze their own construction projects.

Although this study had many findings, the one clear fact established was that after adjusting for inflation, regional cost differences and timing, some units were substantially more expensive than others, even though they were constructed under the same regulatory oversight. Thus regulation cannot be labeled as the only culprit in the nuclear industry's current dilemma.

We contend that project management plays the most crucial role in the development of a successful nuclear facility in spite of what have been referred to as "regulatory hurdles." As the challenges grew and the complexity of the task increased, utility managers - not all, but far too many - repeatedly continued to underestimate the challenge.

For example, between June 1974 and June 1977, fourteen nuclear projects* were authorized by the Nuclear Regulatory Commission (NRC). The "completed" costs of these fourteen plants range from a low of $2 billion to a high of $5.5 billion for units of roughly the same size and type.

Since these units will do the same thing, generate electricity, it becomes apparent that perhaps managers of the lowest cost projects could have completed almost three units for the price that the managers of the highest cost projects expended for one. To put it another way, if the seven higher cost units had been built at the average of the lower cost units, plant costs would have been reduced by $11 billion. I must remind you that this $11 billion is not a national figure, it is the burden of the ratepayers of only seven utilities. It is also worth noting again, that all of the units were built to the same NRC standards including the changes instituted in response to the accident at Three Mile Island.

Let me give you another example. Two nuclear units* were announced in 1969 and received construction permits within fifteen months of each other, in 1971 and 1972. Both were 1100 megawatt plants. Now, thirteen years later, one plant constructed at a cost of $500 million has been operating since 1976. The other still is awaiting full power operating, and costs, not yet final, are heading toward $4 billion. If it sounds as if Michigan has the answers, I must point out the latter unit was built by a utility under the fiscal regulatory jurisdiction of the Michigan Public Service Commission.

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*See attachments

It is an unfortunate fact that some of the most troubled projects still are underway, that these nuclear expenses are not yet final, nor are they even nearly within the bounds of reason. Under the current regulatory scheme, most public service commissions are not empowered soon enough to curtail such activity. Only upon completion of construction are price tags established and state commissions sought out to provide for redress. So, in the end, it falls to public service commissions to sort out opposing and conflicting claims in order to respond to utility company cost-recovery requests of the order of billions and billions and billions of dollars.

We are sadder, but perhaps wiser, veterans of a process in which gaps in interests and responsibilities among and between utilities, state and federal regulators and others have appeared, been left unresolved and which in the end public service commissions are required to overcome. We are left to determine what impacts resulted — and to assign financial responsibility between shareholders and ratepayers according to what is legitimate and what is not. Nor is that financial assignment completed, even for plants that have become operational. It is apparent that the final costs are not accumulated. Corrections and additions to plant to redress errors, or respond to new regulations, occur with seeming regularity. Other costs continue to erupt from what were determined to be financially-resolved situations; mill tailings are discovered to be too poorly stabilized, steam generators turn out to fatigue far too early, estimated decontamination and decommissioning costs grow with inflation. Finally, spent fuel costs are ever so closely related — technically, administratively and in terms of safety. After nearly thirty years we do not know where and at what cost nuclear waste will be disposed of. That, if left untended, may be the final death knell to this industry that held so much promise at its beginnings.

With over $125 billion already invested in nuclear power and an additional $140 billion expected by the end of the decade, the problems of the United States nuclear power adventure are unequalled within this country's business history. As Forbes Magazine in its "nuclear follies" article of February 11, 1985 so aptly describes the staggering, out-of-control expenditures committed to the U.S. nuclear power program: "only the blind, or the biased, can now think that most of the money has been well spent." The Forbes article's thorough criticism raises grave concerns as well as serious questions regarding the future of this country's nuclear power program. It alleges that "without even recognizing the risk, the U.S. electric power industry undertook a commitment bigger than the space program ($100 billion) or the Vietnam war ($111 billion) and, in little more than a decade, transformed what elsewhere in the world is a low-cost, reliable, environmentally impeccable form of energy into a power source that is not only high in cost and unreliable, but perhaps not even safe."

This is not a comment on the viability of the nuclear option. Rather we note that the range of experience within the industry ranks from excellent to abysmal. Thus, the solutions to the nuclear industry's problems may rest within the realm of individual company responsibility.

Congress must undertake a careful and thoughtful review of this complex problem and will be expected to forge any legislation that can help revitalize the nuclear industry. It is this regulatory commission's hope, however, that in your wisdom you will consider regulation as an important tool in guiding the industry and ensuring public safety and not the culprit in a clearly unfortunate situation.

According to the U.S. Congressional Office of Technology Assessment (OTA), seven major social institutions — utilities, investors, the nuclear industry, nuclear critics, the public, the Nuclear Regulatory Commission and public utility commissions — each have played a signficant part in this controversial technological evolution. The NRC itself has some answers. So does OTA. So do the Missouri Public Service Commission, the New York Public Service Commission and the Michigan Public Service Commission, among others. So, too, do Forbes Magazine and the present Secretary of Energy. They all* point to, among many other factors, the level of competence and aggressiveness of project management.

In proposing solutions to the problems currently facing the nuclear industry in this country, we need to recognize that each of us: state and federal regulators, utility managers, construction contractors, legislators and the public in general, share blame for this crisis and must work toward a solution.

*See attachments

While we of the Michigan Public Service Commission have emphasized the role of utility management in the problems of the nuclear industry, we also recognize several other potential solutions to these problems which warrant study and evaluation. These include:

- standardized plant design whereby "cookie cutter" nuclear plants that are safe and efficient could be constructed in far shorter time than the current "custom-built" units;
- a review of contractor/utility relationships to ascertain the proper incentive-type contracts as opposed to the industry standard "cost plus" contract;
- a more timely and cost-conscious safety and plant performance regulatory process at the federal level that reduces changes to plant design while the units are under construction;
- more on-going involvement by state regulatory commissions in the siting, evaluation of utility management performance and nuclear plant construction monitoring; and
- improved demand forecasting methodologies that will result in better information for utilities and regulators before large projects are undertaken.

Furthermore, it may be helpful for the Congress to evaluate successful foreign nuclear construction programs to determine if our industry and regulators can learn how once again to make nuclear power a viable electricity option in this country.

But the ultimate task in reviving this industry rests in the hands of its managers. Laws alone cannot cure its ills.

Public discontent with business abuses essentially accounts for the beginnings of the regulatory process in this country. How much government and for what purpose ultimately will be determined by the industry itself as it sets about to clean up its own act. Laws evolve when all else fails - to protect the public interest and promote the general welfare. It was Tacitus who told us that, "When the state is most corrupt, then laws are most multiplied." Socrates said "Laws are not made for the good." Knowing that, the industry's fate rests in its own hands.

Thank you. I will attempt to answer any questions that you might have.

Responses By

Edwyna G. Anderson, Commissioner
Michigan Public Service Commission

On

What's Wrong with the Nuclear Industry?

For

House Energy Conservation and Power Subcommittee

July 25, 1985

What's Wrong with the Nuclear Industry?

Responses
By

Edwyna G. Anderson, Commissioner
Michigan Public Service Commission

1. Q. What are the problems affecting the commercial nuclear power industry?

   A. There are many. The basic problem, however, with the commercial nuclear power industry is that nuclear plants are enormously expensive and too many take too long to construct. Much of this, in our opinion is due to ineffective utility management, too great an emphasis on unrealistic demand and load forecasts, difficulty of utility companies to obtain financing, inflation, changing regulation by the Nuclear Regulatory Commission and declining demand for electrical energy in the face of rising prices.

2. Q. What is your evaluation of the relative signficance to the present state of the nuclear industry of each of the following factors:

   - The decline of demand growth;
   - State and federal economic regulations;
   - The difficulties encountered in nuclear power plant construction and operation;
   - The economic structure of the utility industry and the federal system of safety regulations.

   A. While all of these are significant, we feel that ineffective utility management plays the most important role in the cost excesses that exist. We believe this because there have been numerous successful nuclear construction projects from a cost standpoint that have evolved in the same regulatory, economic and construction climate as the failures.

3. Q. What problems do you see affecting the operation of existing plants over the next 15 years? Over the next 30 years?

A. We feel the problems over the next 15 to 30 years will continue to revolve around costs emanating from an unpredictable operating environment. Ineffective utility control over contractors, lack of innovation in dealing with reliability and performance of operating plants, and unresolved waste disposal and decommissioning problems all will continue to increase the cost of nuclear plant-generated electricity.

4. Q. What problems do you see affecting the construction of new nuclear power plants?

A. The central problems that will affect the construction of new nuclear plants will also involve costs. This will include inability to attract investors due to poor track records of construction, the lack of better demand forecasting methodologies, the need for greater state oversight over financial management of nuclear construction projects, dependence of utilities on "cost-plus" contracts with nuclear plant constructors and the inability of some utility managements to admit that they are not capable of undertaking nuclear plant construction. This, plus a hostile regulatory environment will leave final plant costs undeterminable. Without substantial change there can be no nuclear plant future.

5. Q. Which of these problems are susceptible to legislative remedies? How should legislation be structured?

A. First of all, we feel that Congress cannot legislate good utility management. This can only come about by continued efforts by the industry, encouraged by regulators, beginning with the admission that there have been major problems. Legislation can deal with plant siting, design and construction matters and should be carefully evaluated to ensure that the problems being addressed are in fact in need of legislated solutions. The U.S. Congress's Office of Technology Assessment has provided options to restructure organizations that manage construction and operations. They are worthy of Congressional review.

6. Q. What are the solutions to these problems?

A. Industry needs to solve its own problems of construction management and operation of nuclear plants. Some companies should not be in the nuclear business while others have shown that they can produce reasonably priced, efficient and safe nuclear plants. Some standard of performance should be established and should guide industry. Congress should focus on national issues that will streamline the regulatory process without losing the important aspects that have served the public well for many years. These might include:

-standardized plant design whereby "cookie cutter" nuclear plants that are safe and efficient could be constructed in a far shorter time than the current "custom-built" units;

-a more timely and cost-conscious safety and plant performance regulatory process at the federal level that reduces changes to plant design while units are under construction by establishing adequately low risks before construction is begun;

-a review of contractor/utility relationships to ascertain the proper incentive-type contracts as opposed to the industry standard "cost plus" contract;

-improved demand forecasting methodologies that will result in better information for utilities and regulators before large projects are undertaken; and

-more involvement by state regulatory commissions at the outset in the sitings, evaluation of utility financial management and in monitoring nuclear plant construction.

TESTIMONY BY

EDWYNA G. ANDERSON, COMMISSIONER
MICHIGAN PUBLIC SERVICE COMMISSION

ON

WHAT'S WRONG WITH THE NUCLEAR INDUSTRY?

JULY 25, 1985

ATTACHMENTS

Prepared by
Michigan Public Service Commission
Staff

Ronald C. Callen
Leonard W. Clarkson
Michael A. Fielek

TABLE PREPARED BY MPSC STAFF

UTILITY NUCLEAR CONSTRUCTION DATA

14 NUCLEAR PLANTS	CONSTRUCTION PERMIT-DATE (1)	FIRST CONCRETE POURED-DATE (2)	PLANT COST $ PER KW (3)
Nine Mile Point -2	6-74	5-77	4700
Hope Creek -1	11-74	8-77	3560
Waterford -3	11-74	12-75	2400
Bellefonte -1	12-74	10-76	2320
Comanche Peak -1	12-74	5-75	1690
Catawba -1	8-75	4-76	1700
Braidwood -1	12-75	3-76	1600
Byron -1	12-75	3-75	1680
South Texas -1	12-75	4-76	3000
Callaway -1	4-76	8-76	2480
Palo Verde -1	5-76	5-76	2490
Seabrook -1	7-76	8-77	4000
Perry -1	5-77	5-76	2600
Wolf Creek -1	5-77	6-77	2320

(1) Nuclear Unit Comparable Study - Appendix E, Michigan Department of Commerce, Public Service Commission, January, 1984.

(2) Management Performance Evaluation - Wolf Creek Generating Station, Kansas Gas and Electric Company, May, 1984.

(3) Charles Komanoff, "Assessing the High Costs of New Nuclear Power Plants,' "Public Utilities Fortnightly," October 4, 1984, p. 36.

TABLE PREPARED BY MPSC STAFF

COMPARISON OF TWO CONSTRUCTION PROJECTS

PLANT	CONSTRUCTION PERMIT DATE	OPERATING LICENSE DATE	PLANT COST (BILLIONS OF MIXED DOLLARS)
TROJAN	March - 1971	November - 1975	0.5
ENRICO FERMI 2	September - 1972	July - 1985	3.4*

*Approximate cost by parent company

1. SUMMARY BY MPSC STAFF OF U.S. NUCLEAR REGULATORY COMMISSION VIEWS ON UTILITY NUCLEAR CONSTRUCTION MANAGEMENT

Conclusions of the U.S. Nuclear Regulatory Commission (NRC) were based on an extensive study of utility management. They were contained in a report required by the Congress itself:

"Utilities not experiencing major quality problems:

- separated the nuclear project(s) from their traditional power plant organization.
- staffed their organizations with people who had appropriate nuclear experience and hired experienced AEs and contractors.
- developed teams and kept teams together from project to project.
- hired experienced key personnel and through contract requirement obtained long-term commitments.
- a high degree of design and engineering completion prior to construction, together with regulatory stability, might compensate for a lack of experience."

In addition:

- "A management system was effectively implemented that provided adequate control and oversight over all project aspects.
- The licensee aggressively managed the project, clearly defined the responsibilities and authorities of the participants and provided adequate procedures to insure compliance, especially at th interfaces. Key design drawings were approved and criteria established.
- Safety and quality was put ahead of schedule and cost not only for the licensee but its contractors also.
- Licensing activities were assigned to executive levels keeping communications open and responsive. A constructive, nonadversar working relationship was developed with the NRC.
- A relatively high design completion was attained at the start of the project to keep engineering ahead of construction.

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*W. Altman, T. Ankrum, W. Brach, "Improving Quality and the Assurance of Qualit in the Design and Construction of Nuclear Power Plants," NUREG-1055, U.S. Nuclear Regulatory Commission, May 1984.

- The attitude of senior project management that the NRC could help the project helped avoid unnecessary confrontations that were counterproductive."

In contrast, the NRC report had this to say about a project that ended in disaster and about other poorly-managed utility projects:

> "One chief executive termed his utility's first planned nuclear plant as just another tea kettle; i.e., just an alternative way to generate steam (this was before major quality problems arose at his project). Managerially, the utilities fit their nuclear projects into their corporations' traditional project management scheme, which, in retrospect, may not have been well-suited for nuclear work. Generally, the utility's lack of experience in and understanding of nuclear construction manifested itself in some subset of the following characteristics:
>
> Inadequate staffing for the project, in numbers, in qualifications and in applicable nuclear experience.
>
> Selection of contractors who may have been used successfully in building fossil plants but who had very limited applicable nuclear construction experience.
>
> Use of contracts that emphasized cost and schedule to the detriment of quality.
>
> Lack of management commitment to and understanding of how to achieve quality.
>
> Lack of management support for the quality program.
>
> Oversight of the project from corporate headquarters with only a minimal utility presence at the construction site ..."

2. TIMING AS RELATED TO UTILITY NUCLEAR CONSTRUCTION MANAGEMENT: U.S. OFFICE OF TECHNOLOGY ASSESSMENT AS SUMMARIZED BY MPSC STAFF OF MICHIGAN

Among many other assessments and review, the U.S. Office of Technology Assessment released in its study* of the nuclear option was an assessment of construction project length. The Office of Technology Assessment selected several U.S. nuclear projects to show the extreme variability in construction time. The table is reprinted here:

TABLE 1
CONSTRUCTION RECORDS OF SELECTED U.S. LIGHT WATER REACTORS

PLANT	Construction time[a] (years)	Year of commercial operation[b] (actual or expected)	Cost[c] (actual or expected,$/KWe)
Shortest construction times:			
St. Lucie 2...............	6	1983	1,800
Hatch 2...................	7	1979	607
Arkansas Nuclear One 2....	7	1980	308
Perry 1...................	8	1985	2,200
Palo Verde 1..............	8	1984	1,900
Byron 1...................	8	1984	1,500
Callaway 1................	8	1984	2,500
Longest Construction times:			
Diablo Canyon 1...........	16	1984	1,700
Diablo Canyon 2...........	14	1984	1,700
Salem 2...................	13	1981	704
Zimmer 1..................	13	1985	2,400
Midland 1.................	13	1985	2,700
Sequoyah 2................	12	1982	740
Watts Bar 1...............	12	1984	1,500

[a] Based on construction permit to commercial operation.
[b] "World List of Nuclear Power Plants," Nuclear News, February 1983, and other recent updates.
[c] Komanoff Energy Associates, 1983, expressed in mixed current dollars.

Construction times for the seven short plants ranged between six and eight years while the longest ranged from twelve to sixteen years. Again, all of these plant programs were formed and carried out under the same regulatory framework. It must be noted that not all utility financial histories and funding availability were the same. But clearly neither was management expertise exhibited in these projects. For example, one of the projects under construction the longest was further delayed to repair the error of building part of the plant backwards.

It is worthy of note as to what has happened since 1983 when this data was accumulated. All seven of the shortest time projects have been licensed for full power operation. Of the slowest, only four have been licensed for operation. Two projects have been abandoned at enormous cost.

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*Nuclear Power in an Age of Uncertainty (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-E-716, February 1984)

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3. ASSESSMENT BY THE NEW YORK PUBLIC SERVICE COMMISSION CONSTRUCTION MANAGEMENT

The New York PSC has given its answer* to some of the problems in the area of nuclear utility construction. The comments relate, however, to one company, the Shoreham Nuclear Power Plant construction program managed by the Long Island Lighting Company. This is a $4.5 billion project for which the utility has requested total recovery from ratepayers.

The New York Commission concluded that the utility was imprudent in its construction management, for a total of $1.35 billion, or roughly one-third of the total plant expense. The Commission, in justifying its conclusions, found the following corporate inadequacies:

> "...the company, almost from the outset of construction in 1969, lost effective control over project costs and schedules and did not regain control until at least 1984...."

They elaborated:

> "LILCO:
>
> ---failed to develop a project plan to oversee the management by Stone & Webster Engineering---
>
> ---failed to pay sufficient attention to cost and schedule control---
>
> ---mismanaged the engineering effort---
>
> ---failed to develop and adequately staff quality control programs---
>
> ---did not respond effectively to changes in regulation---."

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*Release, "Commission Cuts $1.35 Billion from Shoreham Cost on Finding of Imprudence by LILCO," New York Public Service Commission, June 26, 1985.

4. ASSESSMENT BY THE MISSOURI PUBLIC SERVICE COMMISSION OF CALLAWAY PLANT CONSTRUCTION MANAGEMENT

The Missouri Public Service Commission rendered its conclusions* in evaluating the management by the Union-Electric Company of the Callaway Nuclear Power Plant. The Commission disallowed almost $400 million of corporate expense for a project the cost of which they nevertheless found below average for comparable plants. The Commission found that Union Electric's costs could not be fully recovered because "there are exceptions which require significant disallowances in order to establish just and reasonable rates."

They concluded Union Electric, especially after deciding to assume total project control as overall manager,:

> "---has (sic) not fully exercised their rights as owners in managing the interface between Bechtel and DIC (the construction firm)---"
>
> ---did not have a reasonable assessment of the status of the project until physical 'walk downs' were accomplished late in the project in 1981" (over 5 years after the start of construction).

The Commission further declared that Union Electric erred because:

> "---design was not sufficiently complete when construction began and that the problem continued throughout the project causing inefficiencies and delays---.
>
> ---did not fully implement its own project control manual."

Further, the Commission rejected the contention that regulatory change alone adequately explains all of the cost overruns, but concluded that "a significant part of the cost increase and delays at Callaway were due to factors within the control" of Union management.

At one point, the Commission recounts the statement by Union's vice-president in charge of nuclear function after six years of construction: "We don't know where we are. We don't know how we are going to get this job done. We must find a way."

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*Report and Order, "In the matter of --- Callaway Nuclear Plant ---," Missouri Public Service Commission, March 29, 1985.

6. Excerpt from "The Challenge For Nuclear Power", address by John S. Herrington, Secretary of Energy to the Nuclear Power Assembly, May 8, 1985, in Washington, D.C.

> "Yes, excessive federal regulation has contributed to the high cost of construction. Yes, state and local agencies have added to the cost. But let's be fair. Industry has to accept its share of the responsibility for where we are. Why didn't industry leaders do anything about their image before Three Mile Island woke them up? There is no excuse for bad planning, for mismanagement, for shoddy construction. There is no excuse for "build as you go" programs or for poor design. It is important that the nuclear industry be open to new and fresh ideas such as the idea of an industry sponsored national academy for training, testing, safety, and evaluation. The Institute for Nuclear Power Operation (INPO) is doing an outstanding job, but no one outside of industry has ever heard of it.
>
> "How many more times do we have to read stories like we read two weeks ago that 12 out of 17 licensed operators at one utility failed the NRC requalification exam, before the industry takes strong dramatic steps at corrective action."

STATEMENT OF SOL BURSTEIN

Mr. BURSTEIN. Thank you, Mr. Chairman.

For over 25 years I think this industry has demonstrated a record of accomplishment that is most unique and well known to the committee members. Despite that success, however, there are many serious problems facing the nuclear industry today.

These difficulties were the subject of a study conducted by the Atomic Industrial Forum who issued a report entitled "Nuclear Power in America's Future in June of 1984." Similar to the one issued by the Edison Electric Institute which the committee has adopted in its record, I would ask that the AIF report also be included along with, of course, the full statement of my own text.

Mr. MARKEY. We will include that in the record without objection.

Mr. BURSTEIN. Both studies made it clear that despite the significant contribution that nuclear power has made American electric utilities would not consider ordering a new nuclear powerplant because of the uncertainties and financial risks presently suffocating this technology.

The major problems creating these uncertainties and risks are primarily institutional, rather than technical. I believe as both of these reports conclude that it is in our national interest that the nuclear power option be revitalized, and that with appropriate adjustments to the way we perceive and regulate nuclear power, we can restore its potential.

It is in this area of regulation, however, that I fear the most problems exist, and the most important changes are needed to make certain that currently operating plants continue to run well, to assure that those under construction are completed on time, and to establish a rational process for handling nuclear plants in the future.

A utility seeking to build a nuclear plant today will not do so unless it knows in advance and with certainty that it can proceed with diligent construction and lifetime operations on a reasonable schedule. The utility's securities holders must also be assured that they have a reasonable opportunity to recover their investments.

Three bills currently pending in the House, H.R. 1029, 1447 and 2488 all address issues which must be considered for future nuclear plants. The bills are in substantial agreement in a number of areas.

All would provide authority for the NRC to issue combined construction permits and operating licenses. We believe that this is a cornerstone of a predictable licensing system. The bills also provide for Nuclear Regulatory Commission approvals of standard designs and for site certification separate from licensing application.

In addition, H.R. 1029 also addresses the need for regulatory stability for operating plants. These concepts are not new to the Congress, and should not require further extensive review and analysis.

In response to your specific questions, Mr. Chairman, I would like to make the following comments. With respect to future demand for electricity, most of us in the industry have adopted a number of programs to control demand growth in our customers' and investors' interest. And we have been generally successful.

But we are rapidly running out of demand side control options. We must, sooner or later, face the inevitability that electricity will continue to provide an increasingly significant portion of the energy to power this country, including the replacement of wornout units and systems. Present economic and nuclear regulation which discourages new plant construction need to be revised.

I do not foresee a significant change in utility structures in the next 15 to 20 years. I see utility suppliers and ratepayers who share in the benefits from new generation assuming a greater share of the risks that have traditionally been borne exclusively by the electric utility. Measures that enable further deployment of nuclear power do not by themselves provide incentive for the utility industry to restructure itself.

Some have suggested standardizing nuclear plants as one way of resolving much of the industry's problems, with each proponent probably defining standardization differently. There should be no question about proceeding with standardization for simplified, more forgiving light water reactors that utilize the best of our historical success record.

I believe the assets represented by partially completed by canceled nuclear units need to be preserved. We are going to need them and it will be faster and cheaper to finish those facilities than to replace them with something else.

Mr. MARKEY. The gentleman's time has expired. The Chair recognizes Mr. R.P. McDonald, senior vice president of the Alabama Power Co., Mr. McDonald.

[Statement of Mr. Burstein follows:]

SUMMARY OF STATEMENT OF
SOL BURSTEIN, VICE CHAIRMAN
WISCONSIN ELECTRIC POWER COMPANY
BEFORE
ENERGY CONSERVATION AND POWER SUBCOMMITTEE
HOUSE ENERGY AND COMMERCE COMMITTEE

JULY 25, 1985

Despite the positive experience we have had with nuclear power in this country, many serious problems face the industry. Studies conducted by the Atomic Industrial Forum in June 1984 and the Edison Electric Institute in February 1985 found that utilities would not order a new nuclear plant because of uncertainties and financial risks suffocating this technology in the United States. These problems are primarily institutional rather than technical and, with appropriate changes, the nuclear power option can be revitalized. It is in our national interest to do so.

Some of the changes are being implemented by the industry itself, particularly since Three Mile Island, to upgrade the design, construction, and operation of nuclear units. Other changes must come in areas of public acceptance and in nuclear regulation. It is in this area of regulation that the most important changes are necessary to keep current plants operating, to assure completion of plants under construction, and to establish a rational process for handling future nuclear plants.

Continuing changes in regulatory requirements have imposed unprecedented burdens on nuclear plant operations. Similar volatile requirements have adversely impacted construction schedules, creating unprecedented financial uncertainties. A utility seeking to build a nuclear plant in this country will not do so unless it knows in advance, and with certainty, that it can proceed with diligent construction and lifetime operations on a reasonable schedule. Utility investors must be assured that they will have a reasonable chance to recover their investments. The three bills now pending in the House address issues necessary for a nuclear future.

We need to encourage future electric generation to meet inevitable energy requirements. No incentives appear sufficient to justify significant restructuring of the electric utility industry. Assets represented by partially completed, but cancelled, nuclear plants should be preserved. We need to maintain a U.S. nuclear infrastructure and above all we need to motivate people to design, build, and operate these facilities.

While much of the regulatory reform can be accomplished without new legislation, it appears necessary that direction be given by the Congress to demonstrate this nation's commitment to a nuclear future.

Statement

of

Sol Burstein

Before

Energy Conservation and Power Subcommittee

House Energy and Commerce Committee

July 25, 1985

My name is Sol Burstein. I am Vice Chairman of the Board of Wisconsin Electric Power Company. I welcome this opportunity to discuss with you some of the problems facing the nuclear industry today and some of the steps I feel must be taken to correct these problems.

With a quarter century of commercial operating experience in the United States, civilian nuclear power has proven its worth. It is a significant and growing component of electric power supply here in the United States, but even more so in many other parts of the world.

Over three hundred forty generating units provided about thirteen percent of the world's electricity produced last year. Twenty-six countries are producing nuclear-generated electricity, and fifteen more plan to do so by the end of the century.

Of the 220 million kilowatts of nuclear generating capacity in commercial service worldwide, the United States is by far the largest producer, with about one third of the total. Last year eighty U.S. nuclear plants produced nearly fourteen percent of our nation's electric generation. This is expected to grow to nearly twenty percent by the end of the decade.

Yet in spite of this positive experience, there are serious problems facing the nuclear industry. These difficulties were the subject of a study conducted by a task force of the Atomic Industrial Forum, who issued a report entitled, "Nuclear Power in America's Future" in June 1984. A similar group representing chief executive officers of member companies of the Edison Electric Institute released its "Report on Nuclear Power" in February of this year. Both studies made it clear that despite the significant contribution that nuclear power has made, and in spite of its future potential, American electric utilities would not consider ordering a new nuclear power plant because of the uncertainties and financial risks presently suffocating this technology. The major problems creating these uncertainties and risks are primarily institutional rather than technical. I believe, as both reports conclude, that it is in our national interest that the nuclear power option be revitalized, and that with appropriate adjustments to the way we perceive and regulate nuclear power, we can restore its potential.

Some of these changes must be implemented by the industry itself. Electric utilities have undertaken a series of initiatives, particularly since Three Mile Island, to upgrade the design, construction, and operation of nuclear power units. The industry's highest priority continues to be the safe operation of the current generation of nuclear power plants. Our self-improvement efforts are probably more pervasive than those in any other parts of the world. However, when we look at the comparative success of nuclear power activities abroad, we cannot help conclude something is basically wrong with the way we accept and regulate nuclear power in the United States. It is here that the most important changes are needed to make certain that currently operating plants continue to run well, to assure that those under construction are completed on time, and to establish a rational process for handling nuclear plants in the future.

Everyone in this business is aware that regulators, faced with decreases in new plant licensing and construction surveillance, are turning more and more attention to prescribing and controlling nuclear plant operations. Instead of achieving stability and maturity, our increasingly successful experience with nuclear power is largely unrecognized. Instead, we see proliferating prescriptive specifications governing nearly every detail of operations, maintenance, personnel qualification, and even management of nuclear utilities. It is no wonder that nuclear unit performance in this country is well below what it could be.

No place have changing regulatory emphases had a greater impact on nuclear power in this country than in the construction field. No place else in the world does it take as long to build a nuclear unit as it does in the United States. Here again, it is a perpetual state of regulatory change that distinguishes U.S. nuclear construction.

A utility seeking to build a nuclear plant will not do so unless it knows in advance, and with certainty, that it can proceed with diligent construction and lifetime operations on a reasonable schedule. The utility securities holders must also be assured that they have a reasonable opportunity to recover their investments.

Three bills currently pending in the House, HR 1029, HR 1447, and HR 2488, all address issues which must be considered for future plants. The bills are in substantial agreement on the underlying rationale for standardization. All would provide authority to the Nuclear Regulatory Commission to issue combined construction permits and operating licenses. The utility industry has long seen such authority as the cornerstone of a predictable licensing system. The bills also provide for Nuclear Regulatory Commission generic approval of standard designs and for site certification separate from a license application. HR 1029, introduced by Congressman Broyhill, also addresses the need for regulatory stability for operating plants. These concepts are not new to Congress, and should not require further extensive review and analysis.

In response to the Chairman's specific questions, I would comment as follows.

With respect to future demand for electricity, most of us in the utility industry have adopted a number of programs to control demand growth in our customers and investors' interests, and we have generally been successful. We are, however, rapidly running out of demand side control options. We must all, sooner or later, face the inevitability of electricity providing an increasingly significant portion of the energy to power this country, including the replacement of worn out plants. Present economic and nuclear regulation which discourages new plant construction must be revised.

I do not foresee a significant change in utility structures in the next fifteen to twenty years. I see utility suppliers and ratepayers, who share in the benefits from new generation, assuming a greater share of the risks traditionally borne exclusively by the electric utility. Measures that enable further deployment of nuclear power do not, by themselves, provide incentive for the utility industry to restructure itself.

Some have suggested standardizing nuclear plants as one way of resolving much of the industry's problems, with each proponent probably defining standardization differently. Others have suggested the deployment of non-light water reactor systems as the way of disposing of the burdensome baggage that comes along with the present technology. I am very much in favor of standardizing simplified, more forgiving light water reactors that utilize the best of our historical success record. I cannot see utilities rushing to adopt a new concept in the next twenty years, the time I believe it will take under present circumstances to design, license, and demonstrate a major new nuclear technology.

The assets represented by partially completed, but cancelled, nuclear units should be preserved. We are going to need them, and it will be faster and cheaper to finish those facilities than to replace them with something else.

We must preserve the nuclear infrastructure in this country or we shall have no nuclear future at all. Without nuclear equipment and material suppliers, without fuel cycle capability, and without support services, we cannot sustain, let alone revitalize, nuclear power.

Above everything else, we need to motivate people to design, build, and operate nuclear apparatus and plants with competence and dedication by restoring pride, honor, and reward to these professions.

One of the major problems with nuclear power is its loss of favor with the American public, with financial communities and rate commissioners, and with many political leaders. Much of the regulatory reform we urge can probably be accomplished without new legislation. I believe, however, that legislative direction in these areas is necessary to demonstrate this nation's commitment to revitalizing the nuclear option, to mobilize public and institutional support, and to foster an invigorating framework between regulator and licensee of respectful understanding and accommodation.

I ask that the Atomic Industrial Forum and Edison Electric Institute reports be made part of the record.

STATEMENT OF ROBERT P. McDONALD

Mr. McDONALD. I thank you for the opportunity to express views from an operational management perspective.

The nuclear power industry once placed a large portion of its faith for safe and productive operations in conformance with the extensive Federal rules and regulations. This is no longer true. The TMI incident illustrated that mere rules and regulations are insufficient.

In order to learn how to provide the added management ingredient and to assure safety and productivity leaders of the U.S. nuclear utilities formed the Institute of Nuclear Power Operations [INPO]. Today INPO is a powerful and effective institution that must be recognized as uniquely suited to our free enterprise, social, economic system.

One of its characteristics is that it promotes excellence among the 55 licensees in the United States, and to a somewhat more limited degree, internationally. It has facilitated many new management initiatives by its members.

Mr. Chairman, I have a copy of the institutional plan which outlines how it goes about this and I would submit this for the record, if you so wish.

[Institutional plan for the Institute of Nuclear Power Operations, May 1985, appears on p. 382.]

Mr. MARKEY. Thank you very much, it will come in very handy for the subcommittee.

Mr. McDONALD. The 55 licensees presently operate 90 reactors. Although a few licensees have three reactors that are almost identical, and several licensees have two that are alike, there is virtually no other standardization among the licensees.

Also, each licensee has its own unique management organization and policies. Although this diversity may be viewed as a national handicap, the nuclear utility industry has, in typical American fashion, established cooperative institutions and organizations to turn part of that handicap into a strength.

There is now a broad consensus among nuclear utilities that we have made good progress with our new management initiatives and that we are steadily increasing our margin of safety. There is also a broad consensus that the Federal licensing and regulatory institutions are long overdue for updating.

Today each utility has such extensive day-to-day management and operational involvement with licensing and regulatory matters that the quality of these Federal activities have direct impact on how well we do our job. In my day-to-day responsibilities I work extensively with the NRC involving licensing, backfitting, inspection, enforcement and other regulating activities.

I'm personally acquainted with and have spent considerable time with each NRC commissioner, key staff directors, my regional administrator, and our onsite chief resident inspector. I respect their professionalism and value their continuing friendships.

Despite the high quality of such individuals, we in the industry are adversely impacted by official NRC actions that reflect ineffective NRC policies, leadership and organizational discipline. These adverse effects are twofold.

First, the prevalence of ineffective NRC leadership and organizational discipline is a degrading influence upon the effectiveness of our own organizations in directly managing the operation and support of our plants.

Second, these actions require us to expend resources that increase the cost of our product. Moreover, they cause the NRC to expend Federal funds ineffectively, in many cases without any identifiable enhancement of nuclear safety. This sad state of nuclear regulatory affairs should not be attributed to individuals within the NRC, or even to the NRC as an entity. The NRC was established and continues to function as mandated by law.

The problem is, that although the NRC's form and policies may have been appropriate at one time, they are now outdated. Our collective knowledge and experience in technical, institutional, and managerial matters involving commercial nuclear power have developed beyond the conceptions of only a few years ago.

For example, the role of INPO was never envisioned in the legislation that established the NRC.

In order to update the NRC to be a highly effective institution, I urge that legislative action be promptly taken to establish single administrator leadership, in lieu of the present commission arrangement. This would be consistent with accepted principles used in most other nuclear power organizations where it is necessary that responsibility, authority and accountability be inseparably assigned with functions of the position.

After this is underway, we must look to the future. Every executive, manager and supervisor involved in the operation of nuclear powerplants know that no serious thought will be given to starting new plants until there is a greatly improved nuclear regulatory environment, including definitive licensing and regulation policies for backfitting, provisions for standardized plants, one-step licensing, and perhaps above all an updated Nuclear Regulatory Agency.

We cannot allow any perception that despite our commitment to safety and productivity and our expected achievements in these areas, both collectively and individually, that the future of nuclear power and the careers of responsible people are dead-ended.

In order to avoid such perception, as well as for real need, we must have backfitting, standardized plant, and one-step licensing for the future. These policies are vital for sustaining the near- and long-term growth of safety and productivity in the operation of our Nation's nuclear powerplants.

Mr. MARKEY. Five minutes on the button. I have a feeling that is the way you run your company, too. [Laughter.]

Ms. Ellyn Weiss from the law firm of Harmon, Weiss & Jordan, and former counsel for the Union of Concerned Scientists. Ms. Weiss.

[Prepared statements of Mr. McDonald follow:]

SUMMARY OF WRITTEN TESTIMONY
of
ROBERT P. MCDONALD
SENIOR VICE PRESIDENT, ALABAMA POWER COMPANY
on
STATE OF THE NUCLEAR INDUSTRY
Before
THE SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER
of
HOUSE COMMITTEE ON ENERGY AND COMMERCE
July 25, 1985

The U.S. nuclear utility industry has established cooperative institutions and organizations to promote excellence and to minimize the handicaps of its heterogeneous nature. It strives to assure nuclear safety and high productivity through higher performance standards rather than dependence upon minimum standards set by Federal rules and regulations.

The nuclear power regulatory institutions and policies need updating with the conversion of the Nuclear Regulatory Commission to an agency headed by a single administrator as an evolutionary step. The Commission presently does not constitute the nuclear regulatory leadership necessary to be consistent with the industry's pursuit of excellence.

Definitive licensing and regulatory policies are urgently needed for backfitting, standardized plants, and one-step licensing to provide a strong stimulus for the motivation of the personnel responsible for continuing the growth of safety and productivity in the operation of our Nation's nuclear power plants.

TESTIMONY OF ROBERT P. MCDONALD
SENIOR VICE PRESIDENT, ALABAMA POWER COMPANY
ON
STATE OF THE NUCLEAR INDUSTRY
Before
THE SUBCOMMITTEE ON ENGERGY CONSERVATION AND POWER
OF
HOUSE COMMITTEE ON ENERGY AND COMMERCE
July 25, 1985

My name is Robert P. McDonald. I am Senior Vice President of Alabama Power Company, responsible for nuclear power generation and associated activities. I thank the Chairman and other members of the committee for the opportunity to express my views on some aspects of the nuclear power industry. First, I would like to provide a brief status on certain facets of managing operating nuclear plants, then I would like to emphasize our problems and legislative needs from an operational management perspective.

OPERATIONAL MANAGEMENT INFORMATION

There are 55 different licensees operating 90 units. Although a few licensees have three units that are almost identical and several licensees have two that are alike, there is virtually no other standardization among the licensees. Also each licensee has its own unique organization and policies for managing its nuclear units.

The nuclear power industry once placed a large portion of its faith for safety and efficient operations in conformance with the extensive Federal rules and regulations. This is no longer true. The TMI incident illustrated that mere rules and regulations are insufficient. More is needed for adequate assurance of safe and highly productive operations. In order to learn how to provide the added management ingredient and to help assure safety and productivity above mere regulatory requirements, leaders of the U.S. nuclear utilities formed the Institute of Nuclear Power Operations (INPO). Today, INPO is a powerful and effective institution that must be recognized as uniquely suited to our free enterprise, socio-economic system. One of its characteristics is that it promotes excellence among the 55 licensees in the United States and, to a somewhat more limited degree, internationally.

The U. S. nuclear utility industry has been more diverse than that of any other nation as evidenced in the numbers of different utility management organizations, the number of reactors each, the types and vendor models of reactors, etc. Although this diversity may be viewed as a national handicap, the nuclear utility industry has, in typical American fashion, established cooperative institutions and organizations to turn at least part of that handicap into a strength.

All U.S. licensees have the following in common:

- subject to licensing and regulation by the Nuclear Regulatory Commission and deeply involved with the NRC on a daily basis.
- members of the Institute of Nuclear Power Operations (INPO).
- committed to obtaining INPO-managed accreditation of their training programs.
- committed to improving the safety and productivity of their nuclear plant operations (with varying degrees of success) with specific attention to the following areas*:
  - organization and administration
  - operation
  - maintenance
  - technical support

  - training and qualification
  - radiological protection
  - chemistry
  - emergency preparedness
  - operating experience review

  * Areas of INPO Performance Criteria

- in various stages of completing licensing and regulatory backfits.
- pursuing resolution of one or more generic equipment problems such as steam generation tube reliability, reactor coolant pipe cracking, diesel generator reliability, main turbine disc cracking, radioactive waste volume reduction, and reliability of certain types of valves and pumps, etc.

Most licensees have all of the following routine reviews, audits, inspections and evaluations of nuclear plant safety:

- continuing inspections by one or more full-time NRC resident inspectors at each plant site.
- specialized plant inspections by teams of one to about five NRC inspectors for two to five days (about 25 or more per year).
- performance evaluations by INPO every 12-16 months. INPO teams consist of 10 to 20 people who spend two weeks on site.
- annual plant inspections by nuclear liability insurance company.
- annual plant inspection by nuclear property insurance company.
- on-going reviews by extended outage insurance company.
- weekly or more frequent reviews by on-site plant nuclear safety review board.
- quarterly or more frequent reviews by off-site corporate nuclear safety review board.

- on-going engineering safety reviews for each plant by independent engineering review group.
- on-going nuclear safety audits by corporate independent nuclear quality assurance group.
- on-going nuclear safety audits by plant independent quality assurance group.
- annual inspections of plant fire protection by independent, non-company group.
- on-going second party, independent inspections of operations, maintenance and other plant activities.

PROBLEMS RELATED TO LEGISLATIVE NEEDS

Problem 1. The Effects of Non-Standardized Design and Licensing in U.S. Plants

Identification and resolution of system problems: For a single plant or small number of similar plants, it takes a long time to identify and determine the nature of potential malfunctions or inadequacies of systems. This problem is being minimized by event analysis and information exchange programs managed by INPO wherein significant operating events are screened, analyzed and the results reported with recommendations to all utility members. Each utility determines whether or not it applies to its plant(s) and takes appropriate action.

Identification and resulution of equipment problems: Among non-standardized plants there are vast differences between sizes, types, and capabilities of equipment. Again, for any given non-standard plant it would take a long time to determine potential malfunctions and repair or modification approaches. In order to minimize this problem, INPO manages a data bank containing information on equipment problems. It is called the

Nuclear Plant Reliability Data System (NPRDS). Each plant enters data and has access to the data of all other U.S. plants.

Plant Performance Capabilities: When operating two or more similar plants, one plant can be compared and managed to compete directly with another. Such comparision and competition spurs excellence of performance. Through the collection of data and distribution of industry performance information, INPO enables each utility to compare its performance with others and to recognize the potential for improvement.

Specialized Training: When each plant is different, a person trained on one plant must receive additional training when he or she goes to another plant. U.S. utilities have no way to minimize this effect.

Modification and Major Maintenance Expense: The modification expense is higher for non-standardized plants since cost of design, procurement, etc. are not reduced by economy of larger scale.

Spares for Major Equipment: Spares for major equipment are very expensive for each plant to keep in inventory but are necessary to avoid lengthy shutdowns. This expense can be reduced by pooling. The industry has a large Pooled Inventory Management program.

Research and Development: Costs for R&D to resolve major design and state-of-the-art problems would be very expensive for any given utility. Utilities having plants that are similar establish owners groups. There is an owners group for each major nuclear steam supply vendor, for steam generator problems, for certain types of diesels, etc. The utility-sponsored Electric Power Research Institute provides additional support.

Manufacturing and Service Support: Non-standardized plant equipment, components, and material are obtained from a vast number of sources. Many of these sources go out of business because the market for any given product is too small. Replacement equipment and parts, as well as service support for non-standard plants, are therefore more expensive than they would be for standardized plants.

Problem 2. The Out-Dated Nuclear Regulatory Commission

In my day-to-day responsibilities, I work extensively with the NRC involving licensing, backfitting, inspection, enforcement and other regulation activities. I am personally acquainted with and have spent considerable time with each NRC commissioner, key Staff Directors, my Regional Administrator and our Chief Resident Inspector. I respect their professionalism and value their continuing friendships.

Despite the high quality of such individuals, we in the industry are adversely impacted, virtually daily, by official NRC actions that reflect ineffective NRC policies, leadership and organizational discipline. Typically, such actions are specious or bureaucratically motivated interpretations or initiations of rules or regulatory guides made by lower level NRC staff personnel. Once initiated they are perpetuated, seemingly ad infinitum. They appear to be beyond NRC's management control. Such actions require us to conduct studies, initiate programs, change programs, modify plant installations and procedures, or simply communicate back and forth trying to push the matters to higher decision levels in hope that someone will conduct a thorough review and make an objective and well-founded decision to terminate or alter the NRC position. These NRC reviews and decision-making are lengthy, burdensome affairs.

These ineffective actions are not transmitted to us by themselves so that they can be easily segregated but are intermingled with some NRC actions of highly professional quality. Their adverse effects are two-fold. First, the prevalence of ineffective NRC leadership and organizational discipline is a degrading influence upon the effectiveness of our organization in directly managing the operation and support of reactor power plant facilities. Second, these actions require us to expend resources that increase the cost of our product. Moreover, they cause the NRC to ineffectively expend federal funds without any identifiable enhancement of nuclear safety.

This sad state of nuclear regulatory affairs should not be attributed to individuals within the NRC or even to the NRC as an entity. The NRC was established and continues to function as mandated by law. The problem is that although the NRC's form and policies may have been appropriate at one time, they are now outdated. Our collective knowledge and experience in technical, institutional, and managerial matters involving commercial nuclear power have developed beyond the conceptions of only a few years ago. The time for change has now become far overdue.

In contemplating changes to our institutions and policies for the licensing and regulation of nuclear power, we must keep in mind the evolutionary nature of the nuclear power industry and the changing perceptions about how far regulations can go without becoming counterproductive to their purpose. The role of INPO was never envisioned in the legislation that established the NRC.

The counterproductive effect of over-regulation is more apparent in the nuclear power industry than perhaps in any other industry. I have no doubt that many NRC actions have had a negative influence on our margin of safety. Specious or bureaucratically-motivated actions frequently occur which direct us away from day-to-day operations and from more thorough and detailed planning. We in no way wish to challenge the need for regulation nor the value of many of NRC's present activities. For example, we believe that our on-site NRC Resident Inspectors provide a direct communication link with the Commission that helps both NRC and us to carry out our individual responsibilities in a highly effective manner.

In order to update the NRC to be a highly effective institution for assuring the safety of nuclear power plants, I urge that legislative action be promptly taken to establish single administrator leadership in lieu of the present commission arrangements. This would be consistent with accepted principals used in most other nuclear power organizations, where it is vitally important that responsibility, authority, and accountability be inseparably assigned with functions of the position. Additionally, the legislative action should provide means for the reorganization of the NRC staff and reporting organizations using the same principal of inseparablity of responsibility, authority and accountability. The purpose of such legislative action should be to take an enabling step toward flexibility for the administrator to work out, with time, the most effective organizational structure and to make it possible for him to change it with evolving needs.

Problem 3. Inadequate Licensing and Regulatory Bases for the Future

The management and supervision of nuclear power plants is demanding. It involves the need for very capable people with extensive knowledge, training, and experience as well as continuing motivation. The vast and intensive planning, control, reviews, oversight, audits, inspections and other nuclear power plant working characteristics would not stimulate or reenforce the motivation of most people in our culture.

As a relatively new industry, the average nuclear power employee is younger than his or her counterparts elsewhere in utilities. These relatively young managers and supervisors understand that there will be no serious thought given to starting new plants until there is a greatly improved nuclear regulatory environment, including definitive licensing and regulation policies for backfitting, provisions for standardized plants, one-step licensing, and perhaps above all, an updated nuclear regulatory agency with greater leadership effectiveness. Because nuclear plant managers and supervisors are necessarily very specialized, only a few can expect alternate career paths. The staffs of most plants are likely to become stagnant.

We must promptly establish licensing and regulatory institutions and policies that provide rational visions for the future. Such actions would provide a strong stimulus for the motivations of those personnel responsible for continuing the growth of safety and productivity in the operation of our Nation's nuclear power plants.

STATEMENT OF ELLYN WEISS

Ms. WEISS. Thank you, Mr. Chairman and members of the committee. Let me address myself directly to the questions you posed.

From my perspective the fundamental problems affecting the nuclear industry are threefold. First, the continuation since the TMI-2 accident of safety problems at operating plants and construction problems with plants being built.

The June 9 incident at Davis-Besse is the latest example of the troubling recurrence of incidents of multiple equipment failures combined with human errors, of the general type which NRC regulations consider incredible.

Two, the lack of public confidence in the nuclear industry and in the NRC. This past decade has seen nuclear skepticism move beyond citizen groups to elected officials. It is a very significant development in my opinion to see the opposition of the Governor and both Senators from Pennsylvania—all Republicans—to the NRC's action authorizing restart of TMI-1.

The NRC and the utility earned this opposition, which was by no means present at the outset, by a course of conduct over a period of years which showed them, in my view, unworthy of the public's trust.

Last, nuclear powerplants cost too much. Of 100 units canceled since 1972 economic reasons were given by the utilities for 84 cancellations.

You've asked us to look into the future and discuss what problems we see affecting the operation of existing plants. I believe one can confidently project into the future a continuation of the present pattern, the repetition of accidents and near misses involving multiple equipment failures and human errors in unforeseen combinations. One can predict this because there is nothing on the horizon to stop it.

Indeed, Davis-Besse is very instructive. The NRC and Toledo Edison had been haggling in a desultory fashion for 6 years over what changes were required at that plant as a result of TMI-2 accident. NRC refused to take a firm stand because of a probabilistic risk assessment showing the probability of just such an accident which occurred at Davis-Besse to be overwhelmingly remote.

All of the elements which lead me to predict the continuation of the present pattern are revealed here. A lack of regulatory backbone; the chaos and delay caused by 90 custom plants, which prevents NRC from even determining what technical changes are required on a plant-specific basis even when it knows what safety problems it is after.

And lastly, the rising influence of probabilistic risk assessments which provide dubious technical but volumetrically impressive means of forestalling safety improvements forever.

These, of course, are exacerbated by the new official constraints on so-called backfitting implemented by NRC policy. If one believes the NRC's own predictions, there is one chance in two of a meltdown in a U.S. reactor in the next 20 years and 1 chance in 10 of 2.

These are not reassuring figures and neither are they pessimistic, because they are derived from PRA's performed by the nuclear industry.

Moreover, as the current generation of plants age we can expect to see more safety problems attributable to aging.

As far as plants under construction, I again see a continuation of the current set of problems. A major source is that construction permits are granted on the basis of designs that are 15 percent complete when construction begins.

Design-as-you-go leads to enormous unpredictability of schedule, soaring costs, and great economic pressures which force choices to be made which may not always place safety first.

There are five interrelated preconditions in my opinion to any revival of the U.S. nuclear industry. There must be a sustained period of trouble-free operation and construction. The public must believe that plants are needed and that the level of risk is acceptable.

The public must believe that the regulators hold their interest paramount, not the economic interest of the industry. The NRC and the industry must play fair with the people and stop seeking ways to cut off public participation. We are smart enough to know the difference between addressing inefficiencies in licensing and systematically stifling public input. And lastly, nuclear power must become economically competitive with the alternatives.

The primary problems are not directly susceptible of legislative solution. They are largely attitude problems whose solutions must begin with the NRC and the industry. NRC has all the needed authority to require the resolution of longstanding generic safety problems, what it lacks is the will.

In our opinion, the most effective measure that Congress can take now with regard to operating plants fall into two areas. First, it can provide for more consistent oversight by establishing an Office of Inspector General, and an independent, Presidentially appointed Nuclear Safety Board modeled partially after the NTSB, and provision of financial support for public participation.

Second, Congress can mandate full resolution of generic safety problems on firm deadline.

The single most important element of any legislation regarding future plants would be to require as a condition of issuance of a construction permit the submission by the applicant and review by the NRC of a design that is complete and resolves known generic safety problems.

Thank you.

Mr. MARKEY. The time has expired. The next witness is Mr. Joseph Swidler from the law firm of Swidler, Berlin & Strelow, a law firm here in Washington, DC. Welcome.

[Statement of Ms. Weiss follows:]

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Summary of Testimony
of Ellyn R. Weiss
on behalf of
The Union of Concerned Scientists

There are 5 interrelated preconditions to any revival of the nuclear power industry:

1. a sustained period of trouble free operation and construction of nuclear plants.
2. public acceptance of the need for and safety of new plants,
3. public confidence that NRC places safety first in decision making,
4. a demonstration that NRC and the industry genuinely accept the importance and value of public participation,
5. nuclear power must become economically competitive.

Legislation has a limited role to play. NRC has all the needed authority to deal with safety problems in operating plants; it lacks the will to use that authority. the most effective role for Congress is to ensure consistent oversight of the agency and the industry by 1) establishing an Inspector General, 2) establishing an Independent Nuclear Safety Board, 3) providing financial support for the presentation of alternative technical views in NRC proceedings. In addition, Congress should mandate the full resolution of generic safety problems on a clear schedule and the installation of needed safety improvements. As regards any "new generation" of nuclear plants, the goal should be to prevent repetition of the problems plaguing the current generation. The single most important step would be to require, as a condition of issuing a construction permit, the submission and review of a complete design which resolves generic safety problems. Elimination of the current "design as you go" system would do more to enhance safety and predictability than all of the provisions combined which regularly come to Congress within the Trojan Horse labelled "Nuclear Licensing Reform."

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Testimony of ELLYN R. WEISS
GENERAL COUNSEL, UNION OF CONCERNED SCIENTISTS
Before the
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER
of the
COMMITTEE ON ENERGY AND COMMERCE
UNITED STATES HOUSE OF REPRESENTATIVES
July 25, 1985
ON THE NUCLEAR POWER INDUSTRY

Thank you very much for the invitation to appear before you today. I am a member of the Washington, D.C. law firm of Harmon and Weiss and have been General Counsel to the Union of Concerned Scientists for the past 8 years. From 1973-1977, I served as an Assistant Attorney General for the Commonwealth of Massachusetts. I have represented a variety of clients since 1973 in cases involving environmental, nuclear safety and energy policy issues before the AEC, the NRC and in the federal courts.

I will address myself to the six questions you posed to me in your letter of July 17, 1985.

1. **What are the problems affecting the commercial nuclear power industry?**

The fundamental problems affecting the industry, as distinct from those affecting all electric utilities, are threefold and are interrelated:

1. The continuation since the TMI-2 accident of safety problems at operating plants and construction problems at plants being built

The June 9, 1985 incident at the Davis-Besse plant in Ohio is the latest example of the troubling recurrence of incidents of multiple equipment failures combined with human errors, of the general type which NRC regulations do not foresee as credible. The NRC office charged with analysis of operating experience reports that about 100 incidents of failure of multiple systems occurred in 1984. (AEOD Semi-Annual Report, July-December, 1984, AEOD/S502, pp. 7-8.)

With regard to plants under construction, this committee is well aware of the sorry history of quality assurance breakdowns at sites around the country. In at least one case, the Zimmer plant in Ohio, a facility theoretically 97% complete has been abandoned (at least as a nuclear plant) because the price tag for performing the work necessary simply to establish the quality of construction as acceptable was prohibitive.

2. The lack of public confidence in the nuclear industry and in the NRC.

The decade of 1980's has seen nuclear skepticism move beyond citizens' groups to local and state elected officials and state utility regulators. While such opposition is not an entirely new phenomenon, it is, in my opinion, a very significant development when one sees, for example, the opposition of the Governor and both Senators from Pennsylvania (all Republicans) to the NRC's action authorizing restart of TMI-1. The NRC and the utility in question earned this opposition - which was by no means present at the outset - by a course of conduct over a period of years which showed them unworthy of the public's trust.

3. Nuclear power plants cost too much.

Over 100 orders for nuclear plants have been cancelled since 1972. A 1983 DOE report ("Nuclear Plant Cancellations: Cause, Cost, and Consequences," DOE/EIA-0392, April 1983) gave the reasons cited by the utilities for these cancellations. Of 100 units, economic reasons (reversal of economic advantage, financial constraints, reduced load growth) were given for 84 cancellations.

The nuclear moratorium is not simply attributable to the reduction in demand growth, because coal units have been ordered during the same period. It is a rational economic response to a range of circumstances including the TMI-2 accident and its dramatic evidence of the financial risk associated with nuclear accidents, the enormous price tag and low reliability of many new units, the widespread occurrence of quality control failures which demonstrate the inability of utility management to control these projects or to bring them to completion on any predictable schedule, and the rejection of this technology by large numbers of people.

2. **What is your evaluation of the relative significance to the present state of the nuclear industry of each of the following factors: the decline in demand growth; State and Federal economic regulation; the difficulties encountered in nuclear power plant construction and operation; the economic structure of the utility industry; and, the federal system of safety regulation?**

In my opinion, of the factors you have listed, the difficulties encountered in plant construction and operation ranks first because this, in turn, causes costs to soar and public acceptance to erode. I would rank the decline in demend growth second.

3. **What problems do you see affecting the operation of existing plants over the next 15 years? Over the next 30 years?**

One can confidently project into the future a continuation of the present pattern: that is, the repetition of accidents and near-misses involving multiple equipment failures and human errors in unforseen combinations. One can predict this because there is nothing on the horizon to stop it.

Indeed, Davis Besse is instructive in this regard. The NRC and Toledo Edison had been haggling in a desultory fashion for 6 years over what changes were required at that plant as a result of the TMI-2 lessons learned. NRC had been dissuaded from taking a firm stand by a probabilistic risk assessment showing that the probability of just such an accident as has occurred at Davis Besse was overwhelmingly remote. All of the elements which lead me to predict the continuation of the present pattern are revealed here: 1) a lack of regulatory backbone, 2) the chaos and delay caused by 90 custom designed plants, which prevents NRC from even determining what technical changes are required on a plant-specific basis to address known safety problems and 3) the rising influence of probabilistic risk assessments in the regulatory regime, which provide a technically questionable but volumetrically impressive means of forestalling safety improvements indefinitely.

These are exacerbated by the new official constraints on so-called "backfitting" implemented by the NRC policy which requires safety improvements to be authorized by the Committee to Review Generic Requirements ("CRGR"). This process is closed to public participation. CRGR required all "backfits" to be justified by cost-benefit analysis which, in turn, rely on probabilistic risk assessment. CRGR has succeeded in bringing safety improvement to a near halt.

If one believes NRC's own predictions, there is approximately one chance in two of a meltdown at a U.S. reactor in the next 20 years and a one in ten chance of two meltdowns. These are not reassuring figures and there is much reason to believe that they are optimistic, since they are derived from PRAs perfomed by the nuclear industry. Moreover, as the current generation of plants age, one can expect to see more safety problems attributable to that process as more pipes corrode, more steam generators leak and more safety equipment reaches the limit of its qualification.

4. **What problems do you see affecting the construction of new nuclear power plants?**

Again, I see a continuation of the current set of problems. Many utilities have been unable to manage the task of constructing a nuclear power plant. A major source of this problem is that construction permits are granted on the basis of designs that are perhaps 15% completed when construction begins. This design-as-you-go process leads to enormous unpredictability of schedule and soaring costs. These, in turn, place economic pressure on utilities and contractors which logically must make itself felt throughout the project. No utility or contractor sets out to build an unsafe or unreliable plant: economic pressures, however, can force choices to be made which do not place safety first. As nuclear plants become more and more expensive and state regulators begin to demand accountability, this situation is not likely to improve.

5. Which of these problems are susceptible to legislative remedies? How should such legislation be structured?

I believe that there are five interrelated preconditions to any revival of the U.S. nuclear power industry:

1. There must be a sustained period of relatively trouble-free operation and construction of nuclear plants.

2. The public must come to believe that nuclear plants are needed and that the level of risk is acceptable.

3. The public must believe that the regulators hold the public health and safety paramount in all decision-making, rather than the economic interest of the industry.

4. The NRC and the industry must play fair with the people and stop seeking ways to cut off or cripple public participation. Such efforts do as much as anything to galvanize opposition. The public and their elected officials are smart enough to know the difference between addressing "inefficiencies" in licensing and systematically stifling public input.

5. Nuclear power must become economically competitive with the alternatives.

With regard to currently operating plants and those nearing completion, the primary problems are not directly susceptible of legislative solution. They are largely attitude problems whose solutions must begin with the Commissioners of the NRC. NRC has all of the needed regulatory authority to require the resolution of long-standing generic safety problems and the timely implementation of solutions; what it lacks is the will to use that authority. It is also unfortunately true that if NRC is not willing to use its authority, there are limits on what Congress can directly do to ensure that it is used.

In my view, the most effective measures that Congress can take now with regard to operating plants fall into two areas. First, Congress can provide for more consistent oversight of the industry and the NRC and for more effective public participation. In "Safety Second: A Critical Evaluation of the NRC's First Decade," published by the Union of Concerned Scientists in February, 1985, we endorse the following measures directed toward these goals:

1. Congress should establish within NRC an Office of Inspector General. The Inspector General should be appointed by the President and confirmed by the Senate. The Inspector General should report directly to Congress, and should have the power to investigate allegations, subpoena persons and documents, and refer criminal cases directly to the Justice Department.

2. Congress should establish an independent, Presidentially appointed Nuclear Safety Board, modeled partially after the National Transportation Safety Board, to investigate the causes of accidents and near misses ("precursors") and to review operations experiences which indicate current or potential safety problems. This Board should also be directed to examine on a continuing basis, the performance of the agency and of the nuclear industry in addressing and resolving important public safety issues associated with the construction and operation of nuclear power plants, and in exploring the overall risks of nuclear power. The Board, assisted by its own staff, would report to the President and the Congress at least annually. This recommendation was made by the Kemeny Commission.

3. The NRC should provide financial support for public participation in its proceedings. In order to assure that important safety issues are fully and fairly considered, the NRC should reimburse competent intervenors who contribute materially to rulemaking or licensing efforts by pressing significant concerns that are not being urged by other parties. In the alternative, the NRC should establish an Office of Public

Counsel. Both recommendations were made by the NRC Special Inquiry Group.

Second, Congress should take action to mandate the full resolution of generic safety problems. UCS endorses the following:

4. Clear deadlines for the resolution of unresolved safety issues must be established and observed.

5. The NRC should require the prompt installation of improvements necessary to meet minimum safety requirements at operating plants, regardless of the cost. A plant should not be permitted to operate in violation of minimum safety requirements simply because the cost of making needed changes is high.

Insofar as new construction permits are concerned, any legislation should have as its overriding goal that the problems plaguing the current generation of reactors not be repeated in the next generation, should there be one. In my view, the single most important element of any such legislation would be to require as a condition of issuance of a construction permit the submission by the applicant and review by the NRC of a design that is complete and which satisfactorily resolves known generic safety problems. Indeed, this element alone would contribute more to safety and predictability than all of the other provision combined which come to Congress each year within the Trojan horse mislabelled "Nuclear Licensing Reform."

6. What other solutions are there to these problems?

I have outlined above in response to question 5 what I consider to be the preconditions for a new generation of nuclear plant orders. It is apparent that these are not by and large matters that can be legislated. They involve changes in attitude and in economic conditions. Misguided attempts to evade the decisive influences of public opinion and economic market forces will surely backfire. In this society, all products, technologies and ideas must stand or fall in these two arenas. Nuclear power is no different. It cannot be forced on an unwilling public.

STATEMENT OF JOSEPH C. SWIDLER

Mr. SWIDLER. Mr. Moorhead, Mr. Markey, Mr. Bryant, I presume I was invited—I have had extensive experience in regulation and in dealing with collegial bodies as long-term general counsel of Tennessee Valley Authority, as chairman of the Federal Power Commission.

Mr. MARKEY. Welcome to the U.S. Congress. That does not meet any test of collegiality, I'm sure that——

Mr. SWIDLER. I have had contacts with Congress. I served also as chairman of the New York State Public Service Commission.

I am pleased that these hearings are being held. And I trust that they are being held with a view to early legislation. That is the greatest need in straightening out the nuclear problem.

I think the way to start is for the committee—where the legislation starts, the subcommittee—to make up its mind now on the fundamental question. There have been lots of hearings. There has been a great deal in the press. There have been many studies. There is a long history.

The question is, should this country have available a usable and effective nuclear option. If the committee should decide that such an option is unnecessary its course is very simple, wind up the NRC in an orderly way.

The same result can be reached more indirectly and more expensively by doing nothing. A failure to act is equivalent to winding up the nuclear industry.

In my opinion, the nuclear power option should be preserved. It is an essential part of the future generation mix, and the alternative of relying almost exclusively on fossil fuels is unacceptable from the environmental point of view.

In order to preserve the industry a stream of orders is necessary, beginning very soon. And it places a great deal of urgency on action by this committee.

The standards in the act for safety in design and construction, for quality of management, for siting, and other requirements should be strict. But a license, when issued, should permit construction on a schedule and budget—adherence to a schedule and budget, or no one will seek a license.

As a practical matter it is impossible, even for those few who have built plants on schedule and budget to have any assurance that they can do it again without a clarification of the act and a consistency in the act and its administration.

The record of other countries shows that this can be done. Other countries build to a budget. They build safely, frequently using U.S. designs. And they build within a half-dozen years.

It has been done in a few cases in this country. But the average is almost twice what is done in other countries.

And it seems to me that this is a problem which should burden this committee, to find a way to establish regulation which will accomplish the same economy, the same assurance of construction on a schedule and budget, which is attained in other countries.

I have a few recommendations to make on the administrative side from my own long experience. In the first place, I advocate a strong chairman system or any agency will fly off in all directions. Someone is needed to set the direction of the agency.

I recommend modification of the sunshine laws in order to permit the benefits of collegiality among the members of a commission, so that they can challenge each other in private, without the presence of lobbyists, without the presence of company officials, without the presence of the press, and assure an interaction which results in the most satisfactory solution to difficult problems.

As it is now, members come into meetings with their minds already made up on the basis of their individual investigations and there is no interaction. There is no joint answer, and the meetings only result in greater hardening of positions.

I also hope that we will have in this country a better atmosphere for the attraction of good people to administrative positions. It is not helpful to destroy the confidence in the public service.

I think, Mr. Chairman, that that concludes my testimony. I have filed a one-page statement, and I have tried to summarize my one-page statement.

Mr. **MARKEY**. Thank you. And any other written statement which you wish to submit to the committee will be included in the record in its entirety.

[Statement of Mr. Swidler follows:]

SUMMARY OF TESTIMONY OF JOSEPH C. SWIDLER

COMMITTEE ON ENERGY
SUBCOMMITTEE ON ENERGY, CONSERVATION AND POWER
HEARINGS ON REFORM OF NUCLEAR REGULATORY PROCESS JULY 25, 1985

My testimony will address some fundamental problems of administration. I do this on the basis of experience as General Counsel of Tennessee Valley Authority (1945-57), Chairman of the Federal Power Commission (1961-65) and Chairman of the New York State Public Service Commission (1970-74).

I urge the Subcommittee, before it begins to draft legislation, to decide whether this country will require a nuclear generation option. If the answer is No, the NRC merely needs authority to wind up its backlog and to oversee the operations of plants in existence and in the pipeline. If the Subcommittee wishes to make it possible for new plants to be built, it should draft a straightforward measure for this purpose. The worst outcome would be to continue a state of ambivalence on this crucial question.

In my opinion, nuclear power will continue to be important as a part of the generation mix. The alternative of almost exclusive reliance on fossil fuels, and particularly coal, would be unfortunate for environmental and other reasons. For example, experience shows that the greater the degree of reliance on an energy source, the more likely it is to be threatened with interruptions.

Manufacturing capability cannot be turned on and off. Much has already been lost. If nuclear plants are to be built in the future, a practical licensing statute must be enacted soon.

The statute should provide both for strict standards of quality and safety, and for administration in a way consistent with plant completion within the half dozen years which is common in other countries. The administrative agency should insist on generous factors of safety in order to avoid a system prone to delays and unpredictable costs. A license, once issued, should provide authority to the licensee to build to completion as provided in the license. The design questions should be out of the way before construction starts.

I recommend the "strong chairman" system of administration and freedom of commission members to meet as a group without the presence of the public. I have never spoken to a member of an administrative board who did not think that the Sunshine laws in their present form were inconsistent with good administration. They destroy the basis of collegiality. Meetings are used to register individual positions reached in advance. There is no opportunity to talk out problems and seek common ground. Only at closed meetings can members, in the free play of discussion and debate, be challenged to justify their positions to each other, and indirectly to the key staff which regularly attend such meetings. At Sunshine meetings, positions are frozen and members become locked in conflict.

Mr. Markey. I would like to ask Mr. Burstein and Mr. McDonald a question as utility executives. In light of the enormous complexity of building a nuclear powerplant, the very high capital costs, the amount of regulation, and the public controversy surrounding a nuclear project, would you recommend to your companies that they build a nuclear powerplant in the future?

Mr. Burstein. I would be glad to respond, initially, Mr. Chairman. As I have indicated, the answer is no under present circumstances. But we do realize that nuclear power has very grave and serious advantages to our ratepayers. We can provide a lot of reliable, economical and environmentally sound capability through nuclear power.

Mr. Markey. Mr. McDonald.

Mr. McDonald. We must restore the credibility of the NRC and we must take those actions which will enable us to plan, construct, and operate plants efficiently and safely. That requires the need for an updated NRC and the one-step licensing and what have you.

Mr. Markey. Under existing conditions would you make any recommendation to build a new nuclear powerplant?

Mr. McDonald. Under existing conditions my only recommendation is let's get on with those legislative steps that can put us in a position to make that decision when the need comes.

Mr. Markey. So you do not—you would be negative then on any——

Mr. McDonald. No, I would not be negative.

Mr. Markey. You would not answer the question then?

Mr. McDonald. The need is not here today in terms of reserve power. We have the need to prepare for the day when it will be here.

Mr. Markey. So if you had a need today, would you recommend nuclear power?

Mr. McDonald. I would do it right after we reformed the NRC and got the one step licensing bill.

Mr. Markey. He's a tough guy, isn't he? I am glad I do not work for Alabama Power. [Laughter.]

Would you build today a new, large central station coal plant, Mr. McDonald?

Mr. McDonald. I do not think I would do that today because the need is not evident.

Mr. Markey. Thank you, Mr. McDonald. Mr. Burstein?

Mr. Burstein. I think I would not on the basis of uncertainty with respect to acid rain legislation and a number of other similar uncertainties and financial risks that attend the fossil——

Mr. Markey. You would not make a recommendation on coal either? You would not make a recommendation for a new coal——

Mr. Burstein. A large central station coal plant. That is the way you asked the question and the answer is similar. The financial risks and regulatory uncertainties in some aspects of coal plant give me the same negative answer.

Mr. Markey. Do you think the States should be more formally involved in choosing the technology of new powerplants, Mr. Burstein?

Mr. **Burstein.** In the States of Michigan and Wisconsin where service territories that my company serves, they already are. And I think quite well and should continue to do so.

Mr. **Markey.** You think so? Ms. Anderson?

Ms. **Anderson.** Well, I would have to say, unfortunately, although I have a great deal of respect for Mr. Burstein's company as one of those regulated by the State of Michigan, we do not have siting authority. We do not certify plants in advance.

There is a very fine line there, because once one begins to get into the whole business of determining whether or not there should be a facility, one may usurp management authority, and we would have to be extraordinarily careful in that regard.

Mr. **Markey.** Can I ask, Ms. Weiss, do you think that the safety regulatory problems are as significant to the present state of the nuclear industry as the mismanagement which resulted in the cancellation of projects such as Zimmer and Midland and Marble Hill and the WPPSS plants?

Ms. **Weiss.** I think the two are to some degree interrelated. A well-managed utility will not only build a plant on time and within schedule and costs, but they will build it safely and in compliance with the rules, and in a fashion where compliance can be easily verified. Of course, that was the problem with Zimmer.

Mr. **Markey.** Ms. Anderson?

Ms. **Anderson.** I am sorry, what was the question?

Mr. **Markey.** Do you think, when you look at Zimmer and Midland and Marble Hill and the WPPSS projects out in the Pacific Northwest, do you look more to mismanagement or to regulatory problems as to cause for their demise?

Ms. **Anderson.** Well, in fairness, one would have to say that there is a combination of factors. But I think that certainly significant, highly significant is the management issue.

If, as I started to indicate before my 5 minutes expired, 14 plants under construction within the range of $2 to $5 billion, if we look very carefully we will recognize that the managers of the lowest cost projects could have built 3 plants for the 1 that the managers of the highest cost facilities built.

When you have that level of success combined with the level of failure one has to look at management.

Mr. **Markey.** How would you improve utility management?

Ms. **Anderson.** Well, you certainly cannot legislate it. Laws are a result of ills in society. They do not come from good. The whole regulatory process started because of business abuses.

Management is going to have to do that itself. And I think they will have to first admit that they have some problems, and second, decide how they are going to resolve them with all of the help that we as regulators and legislators and others can provide.

Mr. **Markey.** Let me ask Mr. Swidler or Mr. Burstein, do you think that any large capital intensive plants can be build under the present system of economic regulation?

Mr. **Swidler.** I am sure that as the capacity gets tighter that some will have to be built. And management decisions made now on an abstract basis will probably yield to the pressures to take care of loads if there is a practical way to protect the stockholder.

But let me add about the differences due to management. Of course there are management differences and they are significant. But these comparisons are raw numbers and they don't take account of the variety of situations of the different companies. A lot depends on the number of intervenors, on the degree of opposition, on the attitude of the people in the community.

If there are resourceful, able antagonists, if they receive encouragement from local agencies, local commissions, then, yes, their costs will be much higher. And they are apt to have to spread their money over so many years that technological change will require a lot of retrofits that might not be required on a shorter time schedule.

So I think it would be helpful to have a more sophisticated analysis of these cost differences. I say this without denying that there are wide differences in these costs which cannot be explained except on a management basis.

Mr. MARKEY. Mr. Burstein.

Mr. BURSTEIN. I think size by itself is not a deterrent, Mr. Chairman. I certainly think that in areas of pipelines, large hydroelectric plants, transmission systems that bring Canadian power to the United States or the Pacific interties along the West Coast of this country, these are examples of large utility participating programs.

Mr. MARKEY. The more traditional oil, gas, coal, or nuclear powerplants.

Mr. BURSTEIN. I beg your pardon?

Mr. MARKEY. Just traditional central station oil, gas, coal, or nuclear powerplants.

Mr. BURSTEIN. As I said before, the uncertainties attendant of things like acid rain in the coal industry. We have already talked about nuclear. Uncertainties of supply and price in gas and oil suggest that we go toward the smaller, less risky—financially less risky and more predictable plants for power generation.

With stable inflation——

Mr. MARKEY. Which would be which kind of plants?

Mr. BURSTEIN. Smaller, less risky generating plants that can be built in a shorter time and that involve a smaller capital risk.

Mr. MARKEY. And what would be the source of power in those plants?

Mr. BURSTEIN. It can be any of the sources that we talk about. Part of our push for standardization includes smaller sized light water reactor plants, for example.

Mr. MARKEY. Thank you. My time has expired. The gentleman from California, Mr. Moorhead.

Mr. MOORHEAD. Thank you. Ms. Anderson, you were just about to make your great conclusion on your talk when your time ran out. In about 30 seconds could you tell us what that major point was that you were just about to make?

Ms. ANDERSON. That we feel that management must do some internal searching, must determine what ills it has and seek to cure them with the assistance from members of entities. That laws themselves will not be the resolution to so grave a problem.

I would respond that this is not a numbers game. That we have within the same jurisdictions, as in the State of Michigan, successes and failures in the same regulatory and economic climates. So we are hardly able to say that it is because of some regulatory process that these failures have occurred.

Mr. Moorhead. In your testimony you state that there have been numerous successful nuclear construction projects from a cost standpoint that have evolved in the same regulatory, economic and construction climates as the failures.

I agree with you that management has played an important role in the cost excesses at certain plants. But I am surprised at your statement that there have been numerous successful nuclear projects in terms of cost.

Commonwealth Edison Co. and Duke—both extremely well-managed utilities—completed recently nuclear plants and put them in commercial operation that took 10 years to build and license.

Aside from St. Lucie, which plants would you refer to as being economic successes?

Ms. Anderson. Well, certainly the very early ones. St. Lucie stands out first and foremost, and Duke Power comes shortly thereafter.

Mr. Moorhead. A lot has changed since then.

Ms. Anderson. Yes, and there is relativity in all of this. The time has lengthened, but there are still some—for example, in 1971 and 1972, two plants started out roughly the same capacity, roughly the same size units, and one of those was completed around 1976 and has been operating successfully since then. The other is continuing under construction, would expect to go online perhaps within another year. And I know about that one because it is in our jurisdiction.

The fact is that it is all relative, but there have been some successes.

Mr. Moorhead. Our absent member, Mr. Meyer, in his written testimony said that many of the problems that utilities have in attracting capital for nuclear projects are the results of actions of State regulatory authorities, particularly the failure to include CWIP in the rate base, and unwillingness to allow utilities to earn a rate return commensurate with the risks of financing nuclear plants.

What would your comment be about that?

Ms. Anderson. I would say simply, what would have happened if CWIP had been allowed in the rate base of any abandoned facility?

Mr. Moorhead. It certainly would have encouraged more people to take the risk in the future on something like that, would it not?

Ms. Anderson. Would have encouraged?

Mr. Moorhead. More plants to—right now the advantage goes to the consumer. If you can get a powerplant online and build nuclear energy, usually the cost to the customer goes down for electric power after the plant is paid for. And if the management has to take the total risk and does not get any benefits, he is not going to take many risks.

Ms. Anderson. Well, I do not think that that is quite the fact. And as a matter of fact, we have just yesterday begun the bailing out process for a circumstance that should not have occurred. But had ratepayers been assessed for the ongoing costs of a facility that was ultimately abandoned, we would be hard pressed to explain the used and useful aspect required by the law.

Mr. **Moorhead**. Mr. Burstein, what are we going to have to do, what is going to have to occur for utility companies again to be attracted to nuclear powerplants?

Mr. **Burstein**. We are going to have to get a predictable process, a national commitment to nuclear power as Mr. Swidler said, as my own complete testimony defines. The leadership of our Federal establishments must decide whether the nuclear option is one that this country wants or does not want.

And if we do, then we have got to get on with the business of establishing an environment in which it can grow and sustain itself. That means predictability. It means some sort of sharing of the risks, as well as the benefits, with all the beneficiaries. It means a leadership role on the part of this Congress to restore public confidence in the nuclear option.

Mr. **Moorhead**. Mr. McDonald, that is a good question for you to answer. And I know you have given us part of the answer before, but I would like to hear what you say in a complete answer.

Mr. **McDonald**. Well, I concur with what Mr. Burstein has said entirely, but I would like to add one dimension. It is easy to talk in generalities and try to wrap the whole thing up. It is more direct and fruitful to take the first step.

I would challenge the Congress to take the first step that is widely recognized as key. And that is, let us get a single administrator who has the responsibility, the authority, and the accountability and let us start with that first step.

We certainly need the others, but there is no need to wait.

Mr. **Moorhead**. That is an interesting comment in view of having seen the commission before us. They looked like they hated each other. At least some of them did, in the testimony that they gave this last week. And it really probably could stand some——

Mr. **McDonald**. Well, I suggest that each one of those gentleman is highly professional, and I suggest that it is the law that is to fault more than any one of them or the NRC as an entity.

They are working under adverse circumstances, the Sunshine law for example. They tried to get together to make things move more and they ran into a buzz saw. They were trying to become effective. We have to have a law that will enable them to work in an updated organization.

Mr. **Moorhead**. I think that Ms. Weiss pointed out that the industry to a great extent, or many times has shot themselves in the foot. They have made a lot of mistakes that should never have been made.

What is INPO doing to promote excellence among the operators of nuclear powerplants?

Mr. **McDonald**. The plan I submitted for the record, they are doing a lot of things. But let me give you a little feel for it.

As I stated, in the past we were dependent upon rules and regulations to try to meet a level of performance to make things safe. That did not work. And I would submit that it was bound not to work because it is the very culture of our Nation that we are a competitive society. We grew up in school with grades, we played sports.

And we had to introduce some sense of performance, of excellence, of competition with our past record and those of our peers, in order to appeal to the individual initiative and best in our managers and people.

Now INPO has gone on this premise, that we are going to an outstanding job. We are going to be competitive with what we have done in the past. We at Alabama Power Co. are trying to run a better plant than his plant, and he—Mr. Burstein at Wisconsin Electric Power—runs a very good plant, and we are having a close race, and he is probably a step ahead of us today.

But that is the kind of initiative that we need to have to make things work. That is the only thing that has proven in our Nation to be successful.

Mr. **Moorhead**. You recently sent a team to France to look into the French system of nuclear regulation. What advice did you bring back from that?

Mr. **McDonald**. I have one interesting fact. That they have had standardized plants now—they started their building program in 1977. Already they have some 30 plants operating. They design their plants in a way that they can perform outages in a minimum of about 22 days compared to our 29. This differences of a week's time means a much lower cost of the product.

We need to have standardization to be able to do that same thing.

Mr. **Moorhead**. The bells from the floor—not to gavel before our chairman did—but I think we have to get over there and vote.

Mr. **Markey**. Mr. McDonald, could I ask you just one legal question? Do you have legal——

Mr. **McDonald**. I'm not a lawyer.

Mr. **Markey**. Do you have legal counsel with you?

Mr. **McDonald**. Yes, I have a counsel with me.

Mr. **Markey**. Have you taken any look at the Sunshine Act and its legal implications in terms of the overriding of that so that they can conduct——

Mr. **McDonald**. Let me say this. And I think it is only fair to my counsel. I am not a lawyer, but I do know—wait, you asked me about the Sunshine. I do know this, and I get back to this institutional law. I know by talking to each one of those commissioners how frustrated they are to have to work in isolation and then meet each other in a controversial situation.

Now, I am not a lawyer, but I know it is not working. And those people were trying to do their service to the country and they are being thwarted. They need your help so they can do their job.

Mr. **Markey**. Sounds like you are glad you are not a lawyer, somehow or other. [Laughter.]

Nonetheless, I think you are probably wise to have counsel with you, and we welcome you as well.

So with that we will thank this particular panel, and when we come back we will have the second panel begin its testimony. Thank you very much.

[Recess.]

Mr. **Markey**. The meeting is reconvened and we will hear from the second panel, Mr. J.S. Moore, the vice president of Westinghouse Electric Co.; Dr. Bertram Wolfe, the vice president and general manager of the nuclear technologies and fuel division of the General Electric Co.; Mr. John Crowley, the manager of advanced engineering for United Engineers & Contractors; and Mr. A. Philip Bray, the senior vice president, Management Analysis Co. of San Diego, CA.

We will again abide by a very strict 5-minute rule. And we would ask all of the witnesses to comply with it. This panel is one that consists of a range of interests that we in the committee want to hear from. It includes representatives of vendors and architects, engineers, and we believe can help the committee to really balance out the record.

So we would ask, if you could all restrict your comments to 5 minutes, and we will begin the testimony with Dr. Wolfe.

STATEMENTS OF BERTRAM WOLFE, VICE PRESIDENT AND GENERAL MANAGER, NUCLEAR TECHNOLOGIES AND FUEL DIVISION, GENERAL ELECTRIC CO.; JAMES S. MOORE, VICE PRESIDENT AND GENERAL MANAGER, WATER REACTOR DIVISIONS, WESTINGHOUSE ELECTRIC CORP.; JOHN H. CROWLEY, MANAGER OF ADVANCED ENGINEERING, UNITED ENGINEERS & CONTRACTORS; AND A. PHILIP BRAY, SENIOR VICE PRESIDENT, MANAGEMENT ANALYSIS CO.

STATEMENT OF BERTRAM WOLFE

Mr. Wolfe. Thank you, Mr. Markey. Incidentally, I may be leaving somewhat early to catch a plane, if that would be satisfactory.

Mr. Markey. Let's vote on that. No, we will give you permission to leave.

Mr. Wolfe. Thank you very much. I am honored to be here and want to thank the subcommittee for its invitation.

We are here today to discuss the future of nuclear power at a time when its importance, indeed, its relevance to the Nation may not be clear. After all, the OPEC cartel seems to be on the ropes, there are no gasoline lines, energy in general is plentiful and its price, if not still falling, at least appears stable.

It seems almost a shame to interject concerns into such an idyllic situation. Perhaps we could instead engage in pecksniffian speculation about the effects of low level radiation, when, in fact, the annual exposure at the boundary of a nuclear plant—indeed, the average exposure at Three Mile Island—is less than I received in flying here from California to this hearing.

Or perhaps we should piously bemoan the high cost and unending schedules of the nuclear plants under construction, while neglecting to ask how it was that we used to build plants in 5 or 6 years, plants which now provide over 10 percent of our electricity, at a cost about equal to that from coal plants and half of that from oil plants, with far less environmental—adverse environmental and health effects than either.

Mr. Chairman, members of the committee, I would suggest that the present energy situation may be a misleading interlude, and that it would be a serious breach of responsibility to allow nuclear power in the United States to languish in its present state.

Consider the following points: In the first part of the next century the 3 billion energy-starved people in the Third World will double in number when conventional oil and gas supplies, now providing two-thirds of the world's energy, will be in steep decline.

Studies indicate that nuclear power may have to expand manyfold to make possible an economically healthy and stable world.

In the United States today half of our foreign trade deficit, $60 billion is due to the importation of oil. Our oil production outside of Alaska has been in decline since the early seventies. And in the next decade Alaskan production is expected to similarly decline.

Almost all of the electricity generating capacity reserves are oil or gas-fired plants, which if needed will further exacerbate our foreign trade problem and increase dependency on foreign supplies.

And finally, I would note that in the world at large nuclear power is assuming an ever more important role at the time that it has been stymied in the United States. Our nuclear nonproliferation policy has in the past, largely and successfully been implemented through the strength and influence of U.S. technological leadership in the field of nuclear power.

We are in the danger of losing our leadership. Of what relevance will threats of denial of U.S. technology and equipment be in the future if equivalent or superior technology is available from others. Even today, because of our lack of influence, technology abroad is unnecessarily moving in directions which may make non-proliferation objectives more difficult to attain.

Mr. Chairman and subcommittee members, nuclear power in the United States is stymied today, not because of technological deficiencies. The successful programs abroad making use of U.S. designs and licensing technology irrefutably demonstrate this.

The major problem is an institutional one which in large measure can be corrected by Congress. The key impediment to a successful nuclear program in the United States is an unworkable nuclear regulatory framework which serves neither the public nor the nuclear venture, and artificially constrains what may be an energy source vital to the Nation.

Nuclear power has its problems and they should not be obscured. I hope you will make it possible for the Nation to make sound decisions about nuclear power based on the need for energy and the benefits and problems of nuclear power compared to those of other available energy sources. To continue to allow the choices to be distorted by unnecessary institutional impediments is a disservice to us all.

Mr. Chairman, my written testimony further elaborates on the points above. I hope it and these few words will be of use to you.

If I have 30 seconds left, I will use that to respond to Ms. Anderson. And I would make this comment to her. She could take the best management team in her list and the cheapest plant, put those together, agree to build that same identical plant, and no one in the world could guess accurately how long it would take to build that plant and how much it would cost. And that is a regulatory system that in my view must be labeled as bankrupt.

Mr. Markey. Thank you, Dr. Wolfe. Mr. Moore.

[Statement of Mr. Wolfe follows:]

PREPARED STATEMENT OF MR. BERTRAM WOLFE

SUMMARY

Although the nuclear industry has encountered serious difficulties in plant construction and operation during its first three decades, U.S. nuclear technology is sound. The central problems facing the nuclear industry are not technological but institutional. Our regulatory process is outmoded and ill serves both the public and the industry. That process should be corrected by enactment of the proposals found in H.R. 1029, H.R. 1447 and H.R. 2488.

The keystone of any licensing reform legislation should be design standardization. Standardization will: (1) provide predictability; (2) lead to better allocation of industry and regulatory safety resources; (3) improve the quality of NRC licensing and regulatory decisions; (4) reduce construction and licensing costs; and (5) enhance the timeliness and effectiveness of public participation.

The declining fortunes of nuclear power in the U.S. have led to a loss of leadership in the international nuclear community and to a loss of leverage in the U.S.'s ability to deal with the problem of nuclear proliferation. If the United States wants to help control the future of a vital energy option and to successfully pursue its nonproliferation objectives, it can only do so through a strong domestic nuclear power program and technological leadership.

Mr. Chairman and Members of the Subcommittee:

I am Bertram Wolfe, a Vice President of the General Electric Company and General Manager of its Nuclear Technologies and Fuel Division. I received a B.A. in physics from Princeton University in 1950, and my Ph.D. from Cornell University in 1955. I entered the nuclear energy field in 1955, and have been there ever since, all but two years of that at General Electric. I have worked in nearly all phases of nuclear energy, from reactor design to development of new reactor concepts. My present position includes the responsibility for all licensing activities for General Electric boiling water reactors worldwide.

In your letter of invitation, Mr. Chairman, you asked me to identify the problems affecting the commercial nuclear power industry and to recommend solutions to these problems.

Let me begin by stating that the nuclear technology now in use in this country is not the problem. On the whole, the eighty-plus nuclear power plants now in commercial operation in this country operate as reliably as coal plants, produce electricity at half the cost of oil plants and less than that of coal plants, and with far less environmental harm than either coal or oil. Nuclear power plants do not produce acid rain, nor do they contribute to the "greenhouse effect," which may be caused by the thirty billion tons of carbon dioxide emitted into our atmosphere annually by burning fossil fuels.

This is not to say that we in the nuclear industry can be complacent about the performance record of nuclear power plants. We have encountered serious difficulties in plant construction and operation. There have been deficiencies that have limited performance, required costly repairs, and led to remedial design changes for future models. There have been serious incidents at Brown's Ferry, at Three Mile Island, and most recently at Davis-Besse, and there have been quality assurance failures.

To explain the present state of the nuclear industry on the basis of these difficulties, however, requires too narrow a focus and misses the central mark. When Bechtel and General Electric can construct a light water nuclear plant in Taiwan in five years, and it takes them twice as long to construct the same plant in Mississippi; when the Japanese and the French, using American technology and designs, can routinely construct light water plants on well defined schedules forty percent shorter than ours at substantially lower cost; and when nuclear plants are cancelled in New England and arrangements are made to import nuclear-generated electricity from Canada, the cause of our industry's problems would seem to transcend the particulars of nuclear technology.

The central problems affecting nuclear power in the United States are not technological but institutional. Perhaps the most important is our present regulatory process that serves neither the nuclear industry, which deserves rational and predictable regulation, nor the public, which deserves assurance that nuclear power plants are safe.

One of the principal institutional defects is the outmoded process by which we license nuclear power plants in this country. The statutory provisions governing the licensing of commercial nuclear power plants were enacted 31 years ago. At that time, there was no nuclear power industry and reactor designs were still in the conceptual and developmental stage. Accordingly, Congress adopted a two-step licensing process -- critically dubbed the "design-as-you-go" process -- that permits the Nuclear Regulatory Commission to authorize construction based on an incomplete and preliminary design, and to defer a final licensing decision until after the design is finalized and construction is complete.

The two-step approach may have been a reasonable choice in 1954 -- indeed, it may have been essential to launching the industry at that time -- but it has caused serious problems. For one thing, because the two-step process postpones many safety decisions until after construction is largely complete, it is often necessary to rebuild or replace systems or components after they have been built or installed. This increases the time required to construct and license plants and escalates their cost to the utilities and their ratepayers. More importantly, as concluded by the President's Commission on the Accident at Three Mile Island (the Kemeny Commission) and the NRC's Special Inquiry Group which investigated the TMI accident (the Rogovin Group), the two-step process, by deferring resolution of many important safety issues until after the plant is largely completed, seriously impedes effective NRC safety regulation. Accordingly, both the Kemeny Commission and the Rogovin Group were critical of the two-step process.

The two-step process also hampers effective public participation in nuclear licensing decisions. The Rogovin report concluded that one opportunity for a public hearing on a nuclear power plant's application is held "too early to be useful, and the other is too late to be fully effective."

The development of standardized designs makes the two-step licensing process obsolete. We now need a licensing process that supports design standardization. The three nuclear licensing reform bills that are now pending before this Subcommittee -- H.R. 1029, H.R. 1447, and H.R. 2488 -- would provide such a process. All three bills contain four elements essential to meaningful licensing reform: provisions authorizing the NRC to grant standardized design approvals, early site approvals, and combined construction and operating licenses, as well as provisions ensuring the stability of regulatory approvals.

The keystone of each of these three bills is, in my judgment, design standardization. I believe that standardization offers the single most important contribution to a more effective licensing and regulatory process and to the assurance of a high level of safety for future nuclear power plants. There are five important reasons why this is so and why standardization deserves to be favorably considered and affirmatively supported by the Congress.

- First, standardization will provide the predictability which is essential to making the multi-billion dollar decision to invest in a nuclear plant;
- Second, standardization necessarily leads to a better allocation of industry and regulatory safety resources;
- Third, standardization will improve the quality of NRC licensing and regulatory decisions;
- Fourth, standardization will substantially reduce the costs of constructing and licensing new nuclear units; and
- Fifth, the pre-approval process, which is an integral aspect of standardization, will enhance both the timeliness and effectiveness of public participation in the licensing process.

Legislation authorizing the Commission to grant standardized design approvals, combined construction and operating licenses, and early site approvals, and providing greater stability to Commission decisions would, in my judgment, go a long way to improve the licensing and regulatory process. Safety issues would be resolved before construction begins, rather than deferred, as they are under the existing two-step approach, until after construction is complete or, in some cases, until after the plant is in operation.

Second, plants could be built in less time and at lower cost under the proposed legislation than under the current system. This fact has been confirmed by a recent study conducted by the Los Alamos National Laboratory. Using computer models to predict the financial impact of various reform scenarios on two representative utilities, Los Alamos estimated that prompt enactment of the proposed reforms would reduce future electric rates of the utilities by as much as sixteen percent at one and twenty-six percent at the other, and that five years could be cut off the time needed to build nuclear plants.

Even apart from the financial effects, this reduction in construction time is vital. How can a utility make a multi-billion dollar commitment predicated on uncertain needs a dozen or more years hence? Indeed, how can our nation plan its energy future on such a basis?

Third, although licensing reform alone cannot restore public confidence in nuclear power, the process changes proposed by the three pending reform bills would make public participation in the licensing process substantially more meaningful.

A second major cause of nuclear regulation's problems is its unstable, unpredictable, undisciplined nature. As Chairman

Palladino observed not long ago, the NRC's "safety priorities have not been made clear, ... our demands on licensee resources have sometimes been excessive, and ... these demands have not always been well coordinated." This problem stems in part from the two-step licensing process which has permitted utilities to build plants before resolving all safety issues and in part from the fact that the NRC has never established a safety goal or provided clear, firm guidance either to its staff or to the industry on when a plant is safe enough. Regulatory requirements have tended to be imposed after the fact, in response to problems that have arisen. And, until recently, there was no framework for the centralized review and analysis of proposed regulatory requirements before they were imposed. While I am sure all requirements were imposed with the best intentions, many were imposed without thorough analysis of their need or their impact on the overall safety of the facility.

I am hopeful that this problem may soon be addressed, at least in part. In 1981, the Commission established the Committee to Review Generic Requirements, which has helped, and the Commission may soon complete action on a new backfit rule. The rule will establish a procedural framework to ensure careful analysis of the need for and safety effects of proposed new requirements, without in any way obstructing the imposition of necessary safety improvements. Congress should encourage the NRC in this direction, and the stability provisions in the three licensing reform bills pending before this Subcommittee would do just that.

Not all of nuclear power's ills can be blamed on the licensing process or NRC regulation, of course. There are numerous other causes. A number of projects have suffered from unproductive state and local government actions; from erratic utility financing, causing inefficient construction scheduling; from inefficient and complex relationships between reactor manufacturers, architect engineers, vendors, and the utility customer; and, of course, from just plain mistakes and incompetence.

All of these factors should be examined and addressed. The nuclear industry needs to set its own house in order and we have been working to do that through, for example, the Institute of Nuclear Power Operations and more stringent quality assurance programs. But industry efforts alone are not enough. The nuclear industry is inextricably intertwined with Federal Government policies and regulations. Nuclear power cannot survive if those government regulations and policies are carried out without consistency and with indifference to the welfare of the enterprise.

All of which leads me to what I fear may be one of the most far reaching consequences of the declining fortunes of nuclear power in the United States -- our loss of leadership in the international community in dealing with the problem of nuclear proliferation. We must not forget that the development of nuclear power in the U.S. and its encouragement elsewhere had its origins in the "Atoms for Peace" program. Atoms for Peace had as one of its primary aims the reduction in the threat of nuclear weapons proliferation. It was recognized that past efforts to prevent the spread of nuclear technology and weapons proliferation by denying other nations any access to our technology and materials were proving unsuccessful. Faced with the prospect that many nations would ultimately develop nuclear weapons capability, President Eisenhower initiated the Atoms for Peace program.

The program's approach to nonproliferation was predicated on the basis of U.S. leadership in the development and application of peaceful nuclear technology, the results and benefits of which would be shared. As later augmented by the Treaty on Nuclear Nonproliferation, in return for U.S. nuclear technology and materials for civil purposes, recipient nations agreed to forego the development of nuclear weapons. Of critical importance, this bargain made it unnecessary for other nations to independently develop a nuclear technology base or put in place indigenous nuclear fuel cycle facilities, such as those for enrichment and reprocessing. As long as the U.S. was a reliable, cost-effective supplier of enriched uranium at nondiscriminatory prices and was active in developing other elements of the fuel cycle, other nations could forego costly investments to develop respective capabilities of their own. And to the extent that the U.S. retained its nuclear technology leadership, it could influence if not shape the direction of technological development and the means of its employment elsewhere.

When we measure the number of nations with nuclear weapons capability today against the number which were projected in 1954 to have nuclear weapons by now, the Atoms for Peace program must be judged an outstanding success. But, as I said, the Atoms for Peace approach depended upon the technological leadership of the U.S. In the late sixties and early seventies, government encouragement and support to maintain this leadership waned and the nuclear licensing system started its road towards regulatory morass.

A key signal of the changed government attitude was the action on enrichment, in which the U.S. had a monopoly. In the early seventies it appeared that future requirements for enriched uranium would exceed the capacity of the existing U.S. enrichment plants. A continuation of the previous "Atoms for Peace" approach would have dictated a reaffirmation of U.S. commitment to provide enriched uranium so as to discourage independent development of this sensitive technology abroad. By this time, however, opposition to nuclear power had increased to the point where it was not politically practical to commit the funds necessary for additional enrichment capacity for fear of facing charges of unwarranted subsidization of nuclear power. Instead, in 1974 the U.S. abandoned its policy of supply assurance and "closed the books" on new enrichment orders. Today, there is a large surplus of enrichment capacity worldwide and the U.S. is a minority supplier of overseas enrichment.

Reprocessing and breeder technology development have suffered comparable fates in this country. Instead of technological leadership over the past decade, the U.S. has practiced technological abstinence with the hope that forbearance in the U.S. would discourage these fuel cycle activities abroad. This policy of abstinence has simply not worked. The rest of the industrial world is determined to move forward with nuclear power and is doing so, independent of directions and influence which in the past were provided by the U.S.

Over the past decade, the U.S. position of world preeminence and technical leadership in all phases of nuclear power has greatly weakened and is in danger of being lost.

In fact, except for the completion of those plants which are already well along in construction, we have withdrawn from the further utilization of current nuclear power technology. The results are alarming. We may soon see a shortage of trained technical personnel -- the people we need to keep existing plants operating safely or regulated soundly -- as our young people are discouraged from entering the nuclear field. We are already witnessing a loss of important component suppliers and the migration of important technical resources to other nations.

As a result, America may not only lose its technological supremacy but its leverage on the nonproliferation issue. Increasingly, in view of the status of nuclear power in the U.S., our nonproliferation efforts are being viewed by the rest of the world as peripheral, irrelevant or even counterproductive. Indeed, Sigvaard Ecklund, then Director General of the IAEA, indicated in 1979 that he doubted whether the Non-Proliferation Treaty (largely the handiwork of U.S. Atoms for Peace initiatives) could have been negotiated and ratified in the atmosphere resulting from the changed U.S. policies and attitudes.

In summary, I believe that if the United States wants to help control the future of a vital energy option, if it wants to continue to pursue its nonproliferation objectives through commercial nuclear power, it can only do this through a strong domestic nuclear power base and technological leadership. To strengthen nuclear power in the U.S. requires that long term institutional arrangements be developed so that legitimate government responsibilities for public safety and international security can be carried out within a framework supportive of nuclear power.

STATEMENT OF J.S. MOORE

Mr. **Moore**. Thank you, Mr. Chairman. I would like to summarize my prepared testimony which I would like to offer for the record, please.

Mr. **Markey**. That will be included in the record in its entirety.

Mr. **Moore**. Regulatory uncertainty is a major problem affecting the nuclear power industry and it must be addressed now. Energy consumption is up 9 percent over the last 2 years and that is reversing previously predicted declines. So the nuclear option becomes ever more vital to U.S. economic stability.

We support the proposed legislation as it will foster needed discipline and provide certainty and stability to all phases of the construction and licensing process. Action by the Congress will also be a strong signal that the U.S. intends to be a reliable international supplier of nuclear plants, equipment and services.

And success in the international market is necessary to insure continued viability of the U.S. nuclear option. And this is a broader consideration.

Proposed licensing reforms are needed to maintain U.S. competitiveness in the international market. Foreign countries are losing confidence in the American regulatory system. They build safe plants in 5 to 7 years using our technical requirements, but a much more efficient licensing process.

When viewing the U.S. licensing as a whole, they are starting to lose confidence in our U.S. technical requirements, and that is manifested by several advanced western countries rejecting unnecessary technical requirements. This results in regulatory proliferation. We already see signs that foreign competition sells plants that are not licensable in their own country.

A more efficient process will stop this trend. It will improve competitiveness, create jobs, and move our technology ahead.

Success in improving our licensing process depends on the combined effect of the proposals taken as a whole. I think this is an important point. Pre-approved standardized designs combined with pre-approved sites have the potential to greatly reduce construction time and cost. But one-step licensing is also necessary for this preapproval and standardization to be effective.

Finally, the industry and the public are not served by the current process where the CP hearing is too early to have any meaningful detailed discussions, and the operating license hearing is too late to affect any significant changes.

The public is served well by the proposed legislation. Their participation will be more meaningful. Power costs will be lower, and jobs will be created. The Broyhill-Hall bill together with the NRC and DOE proposals provide the appropriate structure for stability in construction and licensing processes and would signal utilities that Congress intends nuclear power to be a part of the U.S. energy program.

Considerable agreement has been reached on the key points. We respectfully urge the committee to recommend these proposals to the full committee and the House and use your good offices to work for their prompt passage into law.

Thank you again for the opportunity for appearing.

Mr. **Markey**. There is no question that this is one of the most exciting subjects that this committee listens to, and I would have preferred to have had another member to have yielded to so I could have gone over to the phone.

But I thank you very much. The next witness is Mr. John Crowley, the manager of Advanced Engineering for the United Engineers and Contractors of Philadelphia, PA. Mr. Crowley?

[Statement of Mr. Moore follows:]

THE HOUSE COMMITTEE ON ENERGY AND COMMERCE
SUBCOMMITTEE ON ENERGY, CONSERVATION AND POWER
SUMMARY TESTIMONY
JAMES S. MOORE
JULY 25, 1985

- Regulatory uncertainty is a major problem affecting the nuclear power industry that must be addressed.
- Proposed legislation will foster needed discipline and provide certainty and stability to all phases of the construction and licensing process.
- Action by Congress will be a strong signal that U.S. intends to be a reliable international supplier of nuclear plants, equipment and services.
- While historic U.S. leadership in nuclear regulation is acknowledged and and its principles integrated worldwide, other countries have developed their own -- more efficient -- licensing procedures.
- Success in improving our licensing process depends on the combined effect of the proposals taken as a whole.
- Preapproved standardized designs combined with preapproved sites have the potential to greatly reduce construction time and cost to put plants on line.
- One-step licensing necessary in order for preapproval and standardization to be effective.
- One-step licensing provides for more effective public participation than current two-step process.
- Industry willing to undertake considerable expense to submit essentially complete design if one-step licensing could be assured.
- Westinghouse committed to future of nuclear power. We believe technology is available to respond to current needs.
- Westinghouse can only take this risk in a disciplined, certain regulatory environment.
- Industry must have a very high degree of certainty that all plants built AS DESIGNED, in a quality manner, will be licensed to operate when completed and will be licensed without extensive backfitting.
- The Broyhill-Hall Bill, together with NRC and DOE proposals, provide the appropriate structure for stability in construction and licensing processes and would signal utilities that Congress intends nuclear power to be a part of the U.S. energy program.

TESTIMONY OF JAMES S. MOORE
VICE-PRESIDENT AND GENERAL MANAGER
WATER REACTOR DIVISIONS
WESTINGHOUSE ELECTRIC CORPORATION
ON
NUCLEAR REGULATORY REFORM

Before

THE HOUSE COMMITTEE ON ENERGY AND COMMERCE
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

JULY 25, 1985

My name is James S. Moore. I am Vice President and General Manager of the Water Reactor Divisions of the Westinghouse Electric Corporation. I wish to thank the Chairman and the other members of this committee for this opportunity to express our views on the proposed legislation to reform the licensing process. My personal experience participating in all phases of that process, including licensing and rulemaking hearings for the past 25 years, convinces me that changes similar to those being proposed are essential if the benefits of nuclear power are to continue to be available to the American public.

Westinghouse is a world leader of long standing with extensive experience in all major aspects of the nuclear business. We are in the unique position of having designed more nuclear reactors than any other reactor vendor in the world. Thus, we have accumulated the most direct experience with practically all phases of the licensing process in the U.S. and worldwide. As a result, we have a broad perspective on how licensing affects nuclear power plant design, construction, and operation. It is on this experience that I base my remarks today.

Since I last testified before this committee two years ago, significant changes have occurred in the nationwide energy forecasting picture. These changes have their root in the energy demand decline that took place from 1980 to 1982. Actual electrical energy usage for that period declined by 0.4 percent. This decline, exaggerated by the intense energy and electrical conservation that took place throughout the U.S. at that time, inspired a depressed forecast. Analysts tended to assume that this decline would steadily continue and forecasts to the end of the century were based on these considerations. In response to recent upswings in the nation's economy, it may be wise to amend those conservative figures.

In the period from 1982 to 1984, electrical energy consumption increased by nine percent. This upswing has some utilities seriously questioning their decisions to avoid building additional generating capacity.

An article that appeared in the June 17, 1985, Wall Street Journal efficiently sums up the concerns now facing many utilities. Mark D. Luftig, a utility analyst with Salomon Brothers, was quoted as saying the areas likely to be hit hardest by sudden increased demand are the Southwest, parts of the East Coast, and parts of the Northwest. In the New England area, according to Samuel Huntington, President and CEO of New England Electric, there may be a need for new generating capacity by 1995 in spite of his company's aggressive conservation program. Charles A. Lenzie of Nevada Power stated that new capacity in his area is justified now, but that regulatory uncertainties had to be resolved before his utility would commit to construction of any type.

In this environment where new capacity is being considered, the future of the U.S. nuclear option is vital. A study published by the Ford Foundation, "Energy: The Next Twenty Years," made the significant point that when any major energy option, such as nuclear power, is ruled out, the strain on the options that are left increases dramatically. Furthermore, none of the other conventional electrical generating options - coal, oil, hydro - is without problems of the environmental, economic or technical variety.

I want to emphasize to you that Westinghouse remains firmly committed to the future of nuclear power. Our commitment is exemplified by our involvement in the development of a new generation of nuclear power plant design - the Advanced Pressurized Water Reactor (APWR). This is a major cooperative effort with the Mitsubishi Company of Japan, one of our licensees, and a consortium of Japanese utilities. We view this as an exceptional opportunity to make evolutionary changes in design based on our many years of experience with existing PWR designs. Our goal is to develop an improved plant design which is simpler, inherently safer and more cost effective. Among the benefits which we see in the APWR are improved plant availability, reduced worker occupational radiation exposure and increased design margins.

An example of the improvements which we are designing into the APWR are changes in the emergency core cooling system which ensures that in the unlikely event of a small pipe break, the reactor core will not be uncovered. This almost eliminates the potential for release of radioactivity from the core as a result of such events, and at the same time, significantly reduces the risk of economic loss from such events.

We also believe it is necessary for a single agent to be responsible for all aspects of safety-related plant design and construction and we intend to do this. In doing this, we intend to provide an exceptional level of design and construction control using state-of-the-art computer aided engineering techniques which we pioneered in the nuclear industry in the field of piping and piping support design and analysis.

Finally, we are seeking maximum regulatory accreditation of the design and construction control process in the context of a reference standard plant. In that regard, we have initiated a major U.S. licensing program intended to lead to one-step license certification of a total final plant design. In effect, we are anticipating a favorable regulatory framework which is synergistic to our efforts. Without this underlying framework of regulatory reform to provide the certainty and stability necessary, we may lose this exceptional opportunity.

The Westinghouse commitment to the future of nuclear power can be measured in terms of both money and ingenuity. We have committed in excess of 100 million dollars to this effort alone and are in the process of obtaining more than forty new patents on unique design features. The ultimate irony of our situation is that without the types of improvements contained in the proposed legislation, important American safety technology advances will be first licensed by Japanese companies in Japan.

In large measure, incentives for the Westinghouse APWR program stem from the international marketplace and our need to remain competitive in that arena. While it is true that there is a hiatus in the U.S. with respect to new orders for nuclear power plants and many plants have been cancelled, there remains a substantial international nuclear market. We believe that the proposed regulatory reforms are essential to our ability to maintain the dominant position American suppliers have enjoyed in the international market up to now.

In order for utilities to take advantage of this improved technology to meet their generation needs, concerns such as those expressed by Mr. Lenzie of Nevada Power need to be addressed. Westinghouse strongly supports the regulatory reforms proposed in the bipartisan Broyhill-Hall bill, HR-1029, the NRC bill, HR-1447, and the Department of Energy (DOE) bill, HR-2488. Although these proposals differ somewhat, each would impose much-needed discipline and stability in the regulatory process and would create an important incentive for the development of enhanced nuclear power plant designs. The discipline that would be imposed does not apply just to the NRC, but to the nuclear industry as a whole.

The incentive for developing enhanced nuclear power plant designs depends on provisions to control unnecessary backfitting and to readily accommodate deviations that may occur during construction.

Based on our extensive experience in every phase of plant construction, we at Westinghouse believe discipline is needed in all phases of the process on the part of all the participants - the industry, the NRC and the interested members of the public. The proposed legislation will foster that discipline and provide the certainty and stability now lacking in the licensing process. The present Commission is attempting to modify the licensing process to the extent they can without legislation. However, the industry needs a firm base of Congressional action in order to create an environment that would enable utilities to make appropriate and forward-thinking investment decisions.

Historically, the U.S. has been a world leader in nuclear technology and the NRC has been the leader in setting safety standards and criteria. These technological leadership positions were won and maintained through vigorous technical and regulatory activities in the U.S. This, especially in the early years of nuclear development, enabled the U.S. to achieve an early lead on its international competition. We now have more commercial nuclear power plants in operation than any other country in the world. Currently there are 93 nuclear plants licensed to operate, with the prospect of this rising to approximately 120 in the next five years. This means that the cumulative U.S. experience can be expected to far exceed that of any of the international competition for quite some time. We must have a rational approach to factoring that experience into regulatory requirements if we are to expect other countries to respect our judgments.

U.S. regulatory requirements, including many of the U.S. codes and standards, were adopted virtually verbatim worldwide during the emergence of the nuclear power industry. But while everyone essentially integrated the regulatory requirements into their own regulatory system, they did not adopt the U.S. licensing process. Most countries developed their own, which appear to be more efficient, processes. Three other major nuclear-committed countries - Great Britain, France and Japan - each have a licensing procedures that solve substantive issues at the early stages of a project, employ cost-benefit backfit methodology, and provide for early public participation in a constructive, disciplined manner. This efficiency and sensibility has created environments in which nuclear plants can be constructed in half the time it takes utilities in the U.S.

At present, we see regulatory agencies in many other countries not only using their own regulatory process but also questioning, and in some cases rejecting, new NRC regulations and devising their own regulatory requirements. For example, regulatory bodies in France and Japan have not adopted all of the post-TMI requirements. Also, several countries -- including the United Kingdom, Taiwan and Korea -- have rejected low-population density siting regulations out of necessity and have relied upon the incorporation of engineered safeguards instead.

This departure from U.S. regulatory requirements is being accelerated by the inability of the NRC to incorporate the results of current safety research and development programs into its regulatory requirements. Japanese regulations for emergency core-cooling system performance allow the regulators to consider the results of research and development programs, even those conducted in the U.S. In our own country the results of these multi-million dollar programs are being ignored and requirements are frozen based on the limited research and development data that was available 13 years ago when the Emergency Core Cooling Hearings were conducted. This is in spite of common knowledge that large factors of conservatism incorporated then are no longer necessary, and especially distressing in that a simple procedural change in the regulations, suggested to the NRC by the AIF, is all that is necessary. My point is that this "backfit" issue has two dimensions. Not only does it involve the imposition of unnecessary layers of requirements, but also includes the unnecessary retention of requirements long after the need has disappeared.

The joint program with the Japanese that I mentioned earlier is an example of how pervasive this problem has become internationally. The APWR under development is being designed to meet the regulatory requirements of Japan, not those of the U.S. Of course we are reviewing it against U.S. regulatory requirements in connection with our program to obtain NRC approval for U.S. application, but for functional purposes we are applying Japanese regulations.

We need to be able to compete successfully in the international market during the current hiatus in domestic nuclear power plant orders in order to ensure our ability to respond when the domestic market returns, as I am sure it will. Furthermore, participation in the international marketplace will ensure our continued ability to be able to respond to our customer's needs for services in connection with those plants that are operating. Action by the Congress to provide the needed reforms in the regulatory process will be a strong signal to the international nuclear community that the U.S. intends to continue to be a reliable supplier of nuclear power plants and associated equipment and services and to continue its technological and regulatory leadership. While this will not by itself ensure our success in the international market, it will remove what has become a major impediment to that goal.

At this point, I would like to discuss our views with respect to each of the provisions of the legislative proposals which you are considering. Although I will be addressing each of these provisions on their own merits, it is important that you recognize that these provisions form an overall approach to the regulatory process and that achieving most of the benefits depends on the combined effects of them taken as a whole.

Early Site Approval

This important provision would allow an applicant to obtain approval of sites for nuclear power plants from the NRC without committing to build a particular facility, and even before he has selected any specific plant design. We support this proposal. Combining this provision with an allowance for preapproved designs would significantly enhance a utility's ability to obtain permission from the NRC to begin construction because most of the major decisions necessary for such permission would already have been made. Thus adoption of this provision will enhance regulatory stability and predictability.

Approval of Designs

Preapproved plant designs, particularly if utilized in connection with preapproved sites and protected from unnecessary backfitting, have the potential to greatly reduce the cost and time required to bring nuclear power plants on line and are, therefore, a significant benefit to the public interest. Emphasis on standardization, to limit the number of different designs requiring review and approval and to avoid unnecessary rereview and relitigation of issues, is of obvious benefit to utilities and consumers as well as to the nuclear industry.

Nuclear power plants, TMI notwithstanding, have demonstrated an exceptional record of economic and safe operation. This does not mean, however, that there cannot or should not be further improvements. It must be recognized that any regulatory process has a built-in bias favoring the status quo. Once regulatory approval has been obtained for some activity, there is a strong disinclination to do anything to upset that approval and require rereview. The more cumbersome and uncertain the regulatory process, the greater is the disincentive. On this basis alone, we believe that the regulatory reforms being proposed have considerable potential for making improvements. It is very important in considering legislation to improve the regulatory process that we eliminate, wherever possible, existing stumbling blocks and to avoid creating new ones.

Licensing Stability

No one could be opposed to backfitting when the expenditure of time and resources for such actions are justified on the basis of the overall benefits to public health and safety. On the other hand, the absence of a rational evaluation process prior to imposing backfits and the adverse, cumulative effect of multiple backfits, should be a concern. We are especially concerned that many backfits do not contribute to, and may in fact have detracted from, overall plant safety. More information on this is available in the pertinent section of the President's Private Sector Survey on Cost Control, and NRC report NUREG-0839.

In NUREG-0839, the NRC's own senior management conducted a study of backfitting reported in 1981. They found that many of these new requirements had not been adequately evaluated as to their impact on public health and safety overall. The study also found that the multiplicity of new requirements placed large numbers of workmen in operating plants. This causes an increased opportunity for error and unintentional operational transients. The NRC senior management also found that frequent and numerous modifications resulted in a continued need for retraining operators, which prevented the operators from developing a reliable base of experiences upon which they can rely during plant operations. The primary recommendation of this report was for the NRC to take prompt action to bring the issuance of new requirements under better control.

More recently, studies performed by the Investigative Staff of the House Appropriations Committee and by Mr. James R. Tourtellotte, Chairman of the NRC Regulatory Reform Task Force, have reemphasized the importance of a national evaluation process prior to imposing backfits.

Examples of improper backfits, as well as debates over their efficacy, tend to detract from the larger question of public interest. The NRC itself admits that it does not know whether or not the majority of required backfits provided overall safety benefits, because no evaluation was performed. More importantly, the cumulative effects of backfitting, the diversion of limited resources from other activities important to overall safety, and the indirect adversities of backfitting are never evaluated. We estimate that $3 billion has been spent to backfit 41 plants, which represents 25% of the initial cost of these plants. Considering this huge total cost incurred by utilities and imposed on ratepayers, the current process clearly is not in the public interest.

The experience of the last decade indicates that the NRC needs a clear expression of support from the Congress to initiate reform of the backfit process. Westinghouse supports the inclusion in any licensing reform bill of specific backfitting provisions setting forth the standards the NRC should use and specifying the factors the NRC should consider in its evaluation of proposed backfits. HR-1029 and HR-2488 include such provisions, and although we may differ with certain language in the two bills, we generally support their recommendations. HR-1447 provides for regulatory stability only in connection with the combined construction permit and operating license, site permits and design approvals which would be authorized by that bill. We also support this provision, but do not believe it goes far enough in directing the Commission in this important area.

One-Step Licensing

An important feature of the licensing reforms proposed in all three bills is a provision for one-step licensing. This improvement would, in itself, go a long way toward reforming regulatory process. It would provide, moreover, for increased public participation in the nuclear licensing process.

I would especially like to emphasize the relationship between standardization and one-step licensing. The proposed legislation provides for standardization in its provision for pre-approval of designs. For such pre-approval to be effective, however, it should be coupled with a one-step licensing process. When a standardized design has been approved, it is essential that those items relating to the design and the public health and safety not be subject to reconsideration after the standardized plant has been constructed and the large investment made. A complete review, with meaningful public participation, should be required at the front end of the process. Thereafter, the benefits of standardization can accrue only if the license constitutes such approval to construct and operate the plant.

The current process satisfies no one. Although it provides two opportunities for public hearings, it actually foreshortens public participation when compared to the proposed one-step format. The construction permit hearing occurs too early to adequately evaluate the safety of the proposed facility and the operating license hearing is too late since it takes place after the plant is almost entirely constructed and billions of dollars have been invested. The length of time that currently exists, from the time a facility is planned until the time it becomes operational, needlessly adds hundreds of millions, if not billions, of dollars to the cost of a plant. And I do not hesitate to add that the consumer ultimately pays this cost in electrical bills. These avoidable delays are caused in part by the licensing process and the threat of activating dilatory, undirected, obstructive litigation encouraged by the existing process. There are three significant disincentives to the provision of detailed design information in the existing process: (1) the added expense in terms of cost, time and resources which it would take to submit a detailed design prior to the issuance of the construction permit; (2) the essential meaninglessness of submitting such information given the substantial likelihood that the NRC would order major modifications to that design once construction began; and (3) the possibility that the design would be relitigated at the operating license stage anyway.

I believe that industry would be willing to undertake the expense of submitting a more detailed design earlier in the process if it could be assured that its consideration would be meaningful, as it would be under the one-step format. My conversations with utility executives confirm this view. The significant advantage of the one-step process for utilities is permitting them the opportunity to plan for the future with confidence. Under the current regulatory process, a utility ordering a nuclear plant does not know how much it will cost, or how long it will take to complete, two factors which, I might add, are interrelated. The longer it takes to build the plant, the more it will cost since the debt incurred will have to be financed over longer periods of time. For a plant nearing completion at the current time, interest charges alone are more than a million dollars a day.

The public would benefit greatly from a single early hearing on an essentially complete reactor design. Those who participate in the licensing process would have the opportunity to review a design for which all safety-related requirements have been defined, yet before billions of dollars have been spent on the facility and significant changes in the plant are difficult, if not impossible, to make. Consumers generally would benefit from less expensive plants. Not only would the plants cost less because of the fewer number of backfits which would be required during construction, but the plant would become operational more rapidly, thereby significantly reducing the time during which interest would have to be paid on the debt incurred to build it. Consumers also would benefit from the added assurance of access to adequate electricity supplies at reasonable rates to support regional economic growth.

Westinghouse believes so strongly in the benefits of a one-step process that we have initiated with the NRC a major licensing program to lead to one-step certification of the Westinghouse Advanced Pressurizer Water Reactor. Once this certification is complete, utilities will be able to provide the NRC with an essentially complete design at the beginning of the licensing process.

Under the proposals contained in both HR-1447 and HR-2488, an applicant receiving a combined construction permit and operating license would have to satisfy a comprehensive list of requirements --consisting of tests, inspections and analyses each with a specific acceptance criteria--before the plant could be placed into operation. There is a sound basis for concluding that the issues of emergency planning, management ability and operator training can be dealt with in this context. Indeed, the early resolution of these issues would seem preferable. The time to determine whether emergency planning is feasible for a specific site is prior to the time billions of dollars have been spent. Likewise, the ability of a utility to manage the project should be concluded as early in the process as possible. If deficiencies in these areas are found later, the NRC and the public will have ample opportunity to deal with the situation.

Does this process significantly curtail public participation? On the contrary, we believe it would enhance public participation. The inspections, tests, and analyses, and the related acceptance criteria will be considered during the hearing on the combined construction permit and operating license, and will be included within the license. Thus, the public will have an opportunity to participate when the participation would be most meaningful. The public will, furthermore, retain the right to utilize Section 2.206 of the Commission's regulations, which permits it to raise issues before the Commission in the absence of an ongoing licensing proceeding. At the current time, public participants--aside from using Section 2.206--must wait to raise these issues until the operating license is issued, which usually is too late to meaningfully address responsible issues. In addition, the public's right to participate in this early hearing means they can influence the comprehensive list of requirements which must be met before the plant will be placed into operation. I would suggest this gives public participants greater ability to affect the design of the facility than they have under the current process.

Conclusion

One of the things I have emphasized in my remarks is the importance of regulatory reform now if we are to maintain the American position in the international nuclear market. Before I conclude, I want to give you some figures which illustrate the overall importance of the international market to the American public in terms of employment. A single nuclear power plant export award represents approximately 15,000 man-years of direct employment plus another 15,000 man-years of indirect employment spread over a 6 or 7 year design and construction period. Over the lifetime of the plant after it goes into operation, as many as 30,000 man-years of additional employment may be provided through the supply of replacement fuel, components and technical services. This means jobs for engineers, technicians, factory workers and construction workers. It would be a shame to let this opportunity to increase employment opportunities for American workers slip away through inaction.

In conclusion, for all of the reasons I have stated, we support the bipartisan Broyhill-Hall bill and the NRC and DOE proposals with the changes recommended by the AIF and those which I have suggested in my remarks. We respectively urge you to recommend these proposed changes to the full Committee and the House of Representatives and to use your good offices to work for their passage into law. I want to thank you again for this opportunity. I would be pleased to respond to any questions you may have at this time.

STATEMENT OF JOHN CROWLEY

Mr. CROWLEY. Thank you, Mr. Chairman, for the opportunity of addressing this subcommittee and have an opportunity of giving my views on problems besetting the nuclear industry.

The problems facing this industry can be characterized as an industry once healthy and full of promise, now currently in disarray. Features of this disarray involve spiraling construction costs, prolonged schedules, a generally negative public perception, and an increasingly difficult regulatory environment.

For example, involving regulatory criteria from a constructor's point of view have added substantially to large increases in commodity content, for example, wire, cable, concrete, piping and structural steel.

QA procedures requiring a perfection of placement not heretofore known in our industry have led to a continuing decrease in construction labor or craft productivity. For example, in many cases productivity factors of four to six times less than in non-nuclear types of plants. In this regard, nuclear plant rework and backfit require more work hours which significantly decrease total productivity.

The interpretation of design and installation requisites of systems meeting incredibly difficult analytical requirements unique to nuclear plants, lead to construction tolerances of a manufacturing nature; which in some cases are less than one-thirty second of an inch.

Additionally, as-built requirements are interpreted by many to require location drawings of the very smallest detail. The very small tubing, wiring, cable, et cetera, have to be precisely located and installed exactly to drawing locations.

This is not the case in France. They do not go to this level of perfection, and we will see that their performance is incredibly better than ours.

Any deviation from these highly detailed requirements requires a reevaluation by the home office, and consequently, a slowdown in the work and delay in getting the work performed.

This practice is not consistent with past practice in the U.S., or current practice, for example, in France; their nuclear power is very competitive relative to where we are.

The collective impact of the current regulatory status in the U.S. nuclear industry and reaction to it leads to construction schedules 2 to 3 times longer than those of the past and those of current French experience; construction commodities 2 to 3 times higher than in the past and those currently in France; construction craft labor 4 to 5 times higher; and engineering and QA costs 14 to 15 times higher than they were in the past.

The above costs, including those bearing upon time related interest cost, have changed the total cost of nuclear power by a factor of 10 over those U.S. plants built in the past. Currently, the cost of many of these plants individually exceed the entire net worth of the utility.

The decline in load growth driven by the recession, oil embargo and so on has had a major impact on electric utility planning. State and federal economic regulators have had to deal with systems with excess capacity and burgeoning cost with its attendant rate shock.

These cost increases have been driven to a large extent by the evolving interpretation of the federal system of safety regulations. These interpretations have added to increasing difficulty and inefficiencies in nuclear plant construction and operation.

These combined effects have impacted the economic structure of the utility industry. With this background the industry is stalled and new commitments appear nonexistent.

Irrespective of the negative outlook outlined, I feel somewhat optimistic about operation of current units in the future. The unparalleled safety record of the nuclear industry as contrasted with other industries I feel will be increasingly recognized.

Contributions of organizations such as INPO coupled with continued operating experience should lead to a more efficient and trouble free operation. Problems of interim and high level waste storage must be nonetheless resolved in this period.

Construction of new power plants poses a major problem due to a lack of confidence in cost, schedule and regulatory stability. It is difficult to conceive of any new commitments in today's climate.

Legislative remedies related to new plants must provide greater discipline in the more efficient interpretation of regulatory criteria. In this regard, limits should be placed on mechanisms for backfit of new requirements and a continuing redefinition of the intent of Federal criteria.

Federal regulations used to take up two volumes on our shelves. We now have 20 volumes to explain how to use the first two volumes.

Considering that the French nuclear program is based on the pressurized water technology developed by Westinghouse, their performance has been comparably excellent in terms of their decreasing construction schedules, as well as stability in holding cost very near to initial estimates.

Success abroad derives from a nonadversarial regulatory climate, and is also due to a stabilization and standardization of their designs.

I would hope that the Congress would implement U.S. reforms in a manner to take advantage and emulate the French experience where appropriate.

I believe restoration of the industry to a state of better health should involve Federal funding of research and development for advanced concepts. These could include advanced light water reactors, LMR's, HTGR's and concepts perhaps smaller in size and more benign in operational sensitivity.

Thank you.

Mr. SHELBY. Mr. Bray.

[Statement of Mr. Crowley follows:]

SUMMARY STATEMENT OF JOHN H. CROWLEY

TO THE

U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER
OF THE
COMMITTEE ON ENERGY AND COMMERCE
WASHINGTON, D.C.

JULY 25, 1985

Thank you for the opportunity of addressing this Subcommittee on my views on problems besetting the nuclear industry and to offer suggestions as to possible beneficial actions that the Congress may consider.

I am John H. Crowley, Manager of the Advanced Engineering Department at United Engineers & Constructors Inc. I have been involved in Nuclear Power Generation for three decades. This experience includes the Nuclear Navy, General Electric Co., and United Engineers & Constructors Inc.

Problems facing the nuclear industry can be characterized as an industry once healthy and full of promise but one that is currently in disarray. Features of this disarray involve spiraling construction costs, prolonged schedules, generally negative public perception and are increasingly adversarial regulatory environment.

The decline in load growth driven by the recession, oil embargo etc. has had a major impact on electric utility planning. State and federal economic regulations have had to deal with systems with excess capacity and burgeoning cost with its attendant rate shock. These costs increases have been driven to a large extent by industry interpretation of the Federal system of safety regulation. These interpretations have added to increasing difficulty and inefficiencies in nuclear plant construction and operation. These combined effects have seriously impacted the economic structure of the utility industry. With this background the U.S. industry is stalled and new commitments appear nonexistent.

Irrespective of the negative outlook outlined, I feel somewhat optimistic about operation of current units to the future. The unparalleled safety record of nuclear as contrasted with other industries I feel will be increasingly recognized by the general public. Contributions of organizations such as INPO and NUMARC coupled with continued operation experience should lead to more efficient and trouble free operation. Problems of interim and high level waste storage coupled with reprocessing capability i.e. backend of fuel cycle must be solved in this period.

Construction of new power plants poses a major problem due to a lack of confidence in cost, schedule, and regulatory stability. It is difficult to conceive of new commitment in today's climate.

Legislative remedies related to new plants must provide greater discipline in the more efficient interpretation of criteria of the Code of Federal Regulations. In this regard limits should be placed on mechanisms for backfit of new requirements and continuing redefinition of the intent of Federal Criteria (10CFR).

Also, restoration of the industry to a state of better health should involve federal funding of Research and Development (R&D) for advanced concepts. These could include advanced LWRs, LMRs and HTGRs concepts perhaps smaller in size and more benign in operational sensitivity.

These latter concepts could be of great economic value to U.S. not only for domestic application but of equal importance for foreign sales impact to balance of payment.

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U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON ENERGY CONSERVATION
AND POWER
OF THE
COMMITTEE ON ENERGY AND COMMERCE
WASHINGTON, DC 20515

July 17, 1985

Mr. John Crowley
Manager of Advanced Engineering
United Engineers and Constructors
30 South 17th Street
Philadelphia, Pennsylvania 19101

Dear Mr. Crowley:

The Subcommittee on Energy Conservation and Power of the House Committee on Energy and Commerce plans to hold a series of hearings on the state of the nuclear industry and on the proposals to reform the licensing and regulatory process which are before Congress. Topics we expect to explore include plant standardization, regulatory stability, the role of State and local governments, the structure and usefulness of adjudicatory hearings, a comparison of domestic construction and licensing practice with foreign practices, and quality assurance.

The first hearing in this series will be held on Thursday, July 25, 1985, beginning at 2:00 p.m. in the Rayburn House Office Building in a room to be announced. The Subcommittee would like to obtain your views on the following questions:

(1) What are the problems affecting the commercial nuclear power industry?

(2) What is your evaluation of the relative significance to the present state of the nuclear industry of each of the following factors: the decline in demand growth; State and Federal economic regulation; the difficulties encountered in nuclear power plant construction and operation; the economic structure of the utility industry; and, the federal system of safety regulation?

(3) What problems do you see affecting the operation of existing plants over the next 15 years? Over the next 30 years?

(4) What problems do you see affecting the construction of new nuclear power plants?

(5) Which of these problems are susceptible to legislative remedies? How should such legislation be structured?

(6) What other solutions are there to these problems?

Mr. John Crowley
July 17, 1985
Page 2

You are invited to submit a statement of any length for inclusion in the hearing record. Your statement should be double-spaced. You are also requested to submit a one-page summary of your written statement. Your oral presentation to the Subcommittee should be limited to five minutes to allow sufficient time for questions.

In accordance with Committee rules, witnesses scheduled to testify should deliver a minimum of 25 copies of their written and summary statements to the Subcommittee by 2:00 p.m. on July 23, 1985. Also, please bring an additional 80 copies of your statement to the hearing room by 1:30 p.m. on the day of the hearing for distribution to Members of the Subcommittee, the public and the press. Upon your arrival at the hearing, please give your testimony to the Subcommittee clerk.

We look forward to your appearance on July 25. If you have any inquiry concerning your hearing appearance, please contact William J. Manning (202) 226-2424 of the Subcommittee staff.

Thank you for your assistance.

Sincerely,

Ed Markey

Edward J. Markey
Chairman

EJM:mb

July 25, 1985

STATEMENT OF JOHN H. CROWLEY
ON THE STATUS OF U.S.
NUCLEAR POWER PROGRAM

Thank you for this opportunity to make a statement of my views on the status of nuclear power in the United States.

My name is John Crowley. I have been involved in Nuclear Power Applications since my graduation from the Oak Ridge School of Reactor Technology in 1952. My associations, spanning these three decades, include the Nuclear Navy, General Electric Company, and United Engineers & Constructors Inc. I was scheduled to be in Lyon, France today to discuss developments in Fast Breeder Reactor Technology. I feel today's topic here to be of a higher priority.

This statement today is in response to the July 17, 1985 letter from the Hon. Edward J. Markey, Chairman of the U.S. House of Representatives, Subcommittee on Energy Conservation and Power of the Committee on Energy and Commerce. My views have been requested to a series of questions.

1. WHAT ARE THE PROBLEMS AFFECTING THE COMMERCIAL NUCLEAR POWER INDUSTRY?

Needless to say, a statement from me or anyone else for that matter, is not required to remind you that the status of nuclear power in the U.S. is not good. Virtually insurmountable problems can be defined which negatively affect the nuclear power industry, i.e. the lack of nuclear orders for the last eight years; the continuing cancellations; the economic morass surrounding the WPPSS cancellation and potential bond default; the Zimmer problem and possible conversion to coal; the Marble Hill situation; the Midland units problems; pump failure at Palo Verde and recent Commonwealth Edison Byron units QA problem relative to the Atomic Safety and Licensing Board.

These industry problems, along with others, lead to a lack of confidence in projections based on spiraling costs, lengthening schedules, an apparent negative public perception as relates to safety issues and a continuing sense of regulatory instability. The environment in which the government, the industry, the regulatory and the public relate lead to continuing instability of the industry. In short, the problems are exacerbated by a continuing evolution and change in perceived regulatory criteria and their implementation.

A discussion of the elements of regulatory evolution as was presented in the recent Union Electric Callaway rate case is included as APPENDIX A. This report develops the ingredients of regulatory change which has occurred over the last decade.

Historically, the electric utility industry has remained competitive with other energy forms due to diversity. The use of nuclear, coal, oil and natural gas fuels in generation stations have enabled an economic balance to be maintained. Capital cost, fuel cost and operating costs have traded against one another for each of the fuels, in order for a given fuel to remain competitive in the market place. The cost performance of earlier nuclear plant met this competitive criteria quite easily. Today, however the nuclear option is for the most part no longer competitive due to current regulatory interpretations and the public perception relative to safety.

2. WHAT IS YOUR EVALUATION OF THE RELATIVE SIGNIFICANCE TO THE PRESENT STATE OF THE NUCLEAR INDUSTRY OF EACH OF THE FOLLOWING FACTORS:

a. THE DECLINE IN DEMAND GROWTH;
b. STATE AND FEDERAL ECONOMIC REGULATIONS;
c. THE DIFFICULTIES ENCOUNTERED IN NUCLEAR POWER PLANT CONSTRUCITON AND OPERATION;
d. THE ECONOMIC STRUCTURE OF THE UTILITY INDUSTRY; AND,
e. THE FEDERAL SYSTEM OF SAFETY REGULATION?

a. Decline in Demand Growth

The decline in demand growth experienced through the last decade results from inflation, the oil embargo, the economic recession, increased energy price, conservation, and declining birth rates. The increase in electricity cost driven by high oil and gas prices as well as high coal cost driven by environmental features as well as nuclear driven by capital cost increases associated with the evolution of regulatory criteria all contribute to low demand growth. The demand growth will probably never again be in the historic 7 percent regime. However, the economic recovery, low interest rates, baby boom and new household commitments as well as the need will arise to retire or backfit current fossil units to meet new air quality standards, suggest the need to add capacity. We need confidence that project schedules of the last decade can be vastly improved and costs contained however, before a commitment to new nuclear is made. The current nuclear experience in both cost and schedule will probably discourage new commitments to nuclear even if higher load growth is predicted. This outlook is characterized by Chauncey Starr, President of Electric Power Research Institute, as follows:

> "Financial: The long lead times required to bring a nuclear plant on line are usually greater than for fossil fuel alternatives, and create major financing problems. The possibility of delay or reversal of approval represents an unpredictable risk, and thus a large risk for many utilities if the cost of construction work in progress

is not allowed in their rates. Further, utilities are generally faced with the problem that rate procedures and treatment of new investment causes capital expansion to dilute their stockholders' equity and return rate, so most now have a financial disincentive to any kind of capacity growth, despite the popular misconception to the contrary."

b. State and Federal economic regulation

An assessment of regulatory impact of state and federal regulation is beyond the scope of this brief response. Considering the tendency of governmental bodies to react to the voting and rate-paying public, events such as Three Mile Island, Zimmer cancellation, Washington Public Power Supply System bond default, spiraling construction costs and lengthening schedules puts the industry and regulators in an increasingly adversarial relationship. These take the form of fines, citations, prudency hearings and refusal to include all accrued costs in the rate base. Just as utilities share in the inability to predict present events, I believe regulatory bodies should not be permitted their current adversarial role without also sharing responsibility, where appropriate, for lack of foresight in anticipating events and cost and schedule effects.

c. The difficulties encountered in nuclear power plant construction and operation;

Difficulties encountered in U.S. nuclear power plant construction have been reported in a variety of papers and reports. A recent paper "Construction - What The USA Can Learn From France About Keeping Costs Under Control," by John H. Crowley and Robert S. Kaminski was published in "Nuclear Engineering International, July 1985 issue. This paper showed the relationship between USA and France's nuclear programs and identified factors contributing to the excellent French performance. (See APPENDIX B)

Recent studies of construction problems were reported in the Department of Energy sponsored case studies, "Nuclear Power Plant Cost Drivers," UE&C-830729 dated September 1983. These studies reported design and construction problems as impacted by interpretation of regulatory criteria.

Evolving regulatory criteria has added substantially to large increases in commodities i.e. wire and cable, concrete, piping and structural steel. QA procedures requiring "perfection" of placement have led to a continuing decrease in craft productivity, i.e. in many cases factors of 4 to 6 less than non-nuclear plants. In this regard rework and backfit require more work hours which significantly decrease total productivity.

Interpretation of design and installation requirements of systems meeting analytic requirements lead to construction to tolerances more restrictive than normal construction practices i.e. 1/32 of an inch.

As-built requirements are interpreted by many to require location drawing of the smallest detail i.e. small tubing, wiring, cable etc. to be precisely located and installed exactly to drawing location. Any deviation requires re-evaluation by home office engineers for approval. This practice is not consistent with past practice in the U.S. or current practice, for example, in France.

In summary the collective impact of the current regulatory status and the industry reaction leads to:

1. Construction Schedules two to three times longer than those of the past and current French experience.
2. Construction Commodities 2 to 3 times higher
3. Construction Craft Labor 4 to 5 times higher

4. Costs including the above and time related effects of inflation and AFDUC up to 10 times in certain cases.

d. The economic structure of the utility industry;

The economic structure of the utility industry has historically been a state and/or federal monopoly wherein rates of return covering debt equity structure are determined and granted by state public service commissions. This system served quite well when load growth was predictable and a diversity of electric generating alternatives at predictable cost and schedule were put on line in an atmosphere of public acceptance and a non-adversarial and cooperative state and federal regulatory relationship.

There are those who may have forgotten that many of the current nuclear projects were enthusiastically encouraged by the U.S. Atomic Energy Commission of an earlier date when the commission had the promotional as well as the regulatory function.

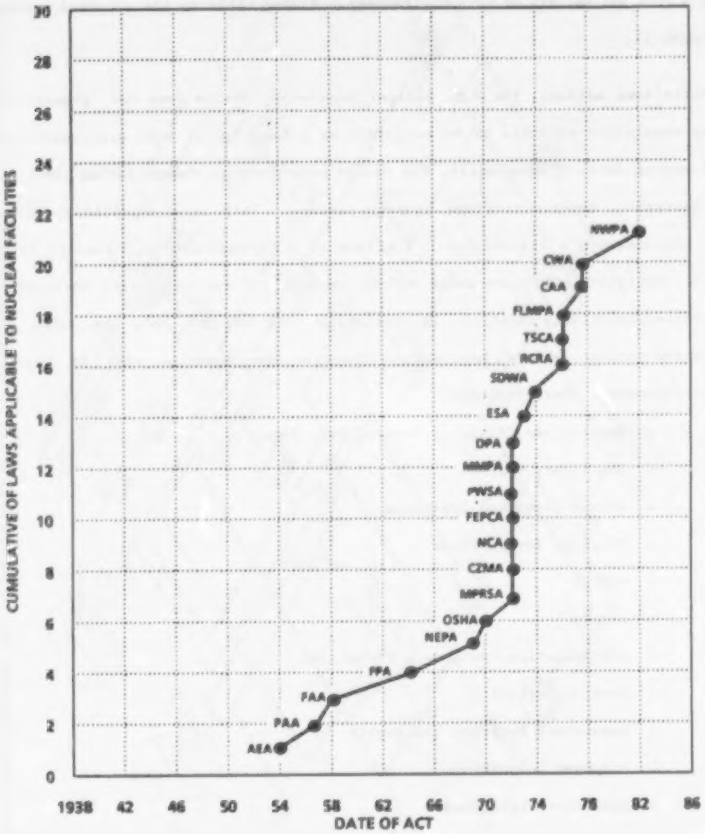
The economic structure of the utility industry today is in shambles in many areas with high cost nuclear generation coupled with low or negative load growth. For many utilities the current cost of new nuclear units on line is well in excess of the net worth of the company. Threatened bankruptcies abound in addition to bonds in default.

The significances of the current economic structure is such that financing for new nuclear ventures will be difficult and costly to obtain if at all.

e. The federal system of safety regulation.

The U.S. regulatory environment has been unstable during the last decade and a half with respect to both legislation and safety requirements promulgation. FIGURE I shows the history of U.S. Congressional legislation which has impacted nuclear power plant construction. In addition the regulatory environment

FIGURE I



UNITED STATES FEDERAL LAWS APPLICABLE TO NUCLEAR FACILITIES FROM 1954 TO 1984

LEGEND:

NWPA - Nuclear Waste Policy Act, 1982
CWA - Clean Water Act, 1977
CAA - Clean Air Act, 1977
FLMPA - Federal Land Policy Management Act, 1976
TSCA - Toxic Substances Control Act, 1976
RCRA - Resource Conservation and Recovery Act, 1976
SDWA - Safe drinking Water Act, 1974
ESA - Endangered Species Act, 1973
DPA - Deepwater Port Act, 1972
MMPA - Marine mammal Protection Act, 1972
PWSA - Ports and Waterways Safety Act, 1972
FEPCA - Federal Environmental Pesticide Control Act, 1972
NCA - Noise Control Act, 1972
CZMA - Coastal Zone Management Act, 1972
MPRSA - Marine Protection, Research and Sancturies Act, 1972
OSHA - Occupational Safety and Health Act, 1972
NEPA - National Environmental Policy Act, 1969
FPA - Federal Power Act, 1964
FAA - Federal Aviation Act, 1958
PAA - Price-Anderson Act, 1957
AEA - Atomic Energy Act, 1954

associated with achieving nuclear safety has been very unstable. In referring to the U.S. Regulatory Environment and federal laws, please note that the NRC is a part but not all of this environment. Please refer to the attached exhibit, FIGURE II.

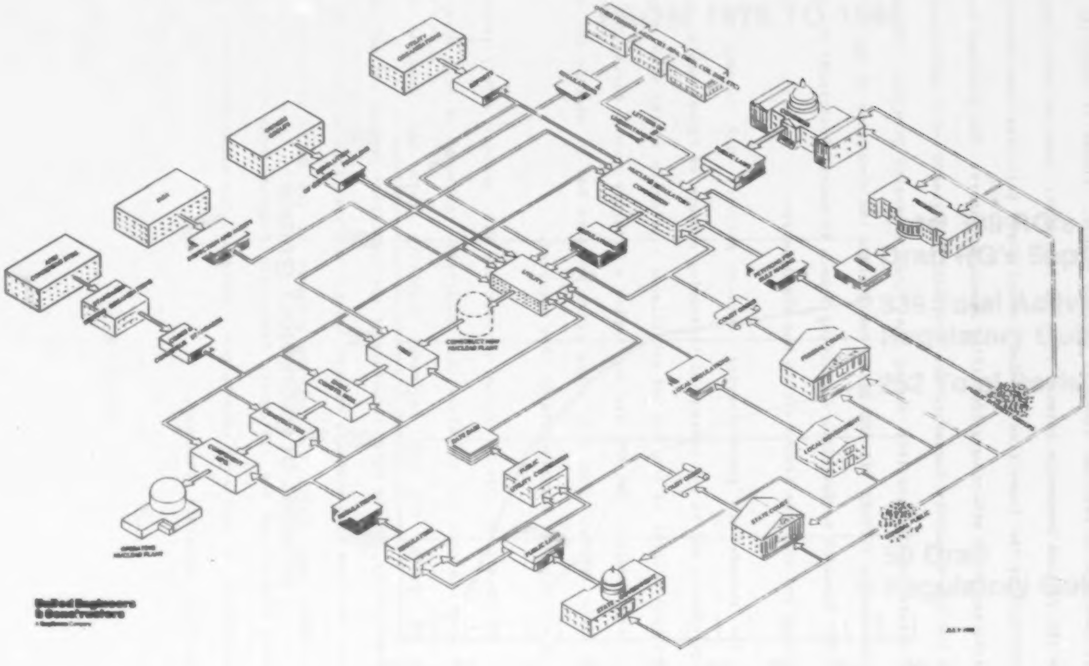
Unlike some nations, the U.S. Nuclear Regulatory system does not "grandfather" the regulatory criteria to be satisfied as a function of some pre-construction licensing date. Consequently, the design is subject to change during the entire engineering, construction and startup process. This is a significant element in the industry's instability. The lack of a "grandfathering" feature in the U.S. regulatory structure would not be important if the regulatory requirements remained relatively stable. Unfortunately this has not been the case. The current nuclear safety regulatory structure has numerous ways of imposing requirements. These include:

- Regulations (Title 10 Code of Fed. Reg.)
- Regulatory Guides
- Branch Technical Positions
- Standard Review Plans
- NUREGS
- Orders
- I/E Bulletins (Notices & Circulars)
- Generic Letters
- Regulatory Position Statements
- Proposed Rulemakings
- Inspector Preferences

The U.S. NRC Regulatory Guide Series incorporated and supplemented the older, Atomic Energy Commission Safety Guides. The growth in NRC Regulatory Guides between 1970 and late 1984 is shown on FIGURE III. In addition the Inspection

FIGURE II

ORGANIZATIONS CONTRIBUTING TO THE U.S. NUCLEAR REGULATORY ENVIRONMENT


NUCLEAR REGULATORY COMMISSION
UTILITY
PUBLIC LAWS
COURT ORDERS
FEDERAL COURT
STATE COURT
LOCAL GOVERNMENT
LOCAL REGULATIONS
PUBLIC UTILITY COMMISSION
CONSTRUCTION
CONSTRUCT NEW NUCLEAR PLANT
OPERATING NUCLEAR PLANT
GENERAL PUBLIC
United Engineers & Constructors

and Enforcement Branch of the U.S. NRC also issued various documents reflecting its position on problems found in various plants. FIGURE IV shows the growth in I&E related documents between 1976 and late 1984. Some of these documents, particularly the Inspection and Enforcement (I&E) Bulletins were identified as mandatory while others were identified as non-mandatory. The problems discussed in the non-mandatory documents are frequently addressed on a contingent basis to insure knowledgeability during the final licensing process. The numbers presented in FIGURES III AND IV do not include the increases in and revisions to NRC Standard Review Plans (including Branch Technical Positions) and special studies and analyses issued within the NUREG series.

In the absence of "grandfathering" nuclear projects with respect to safety requirements and in the present of increasing numbers of requirements, it would have been helpful if the NRC had established a priority system with respect to new requirements. The NRC did not employ a priority system during the 1970's and early 1980's. Thus U.S. power plant projects had to address the changes from all relevant requirements as they occurred.

The net result of this situation is that the U.S. nuclear safety environment has been unstable and therefore very uncertain. Although we have always been and are hopeful for some increased stability there have been no changes unfortunately, in the basic structure of the regulatory process and environment. There has been some emphasis on cost benefit analyses internal to the NRC which has added some stability. But the presence of the NRC's Unresolved Safety Issues Program and the Systematic Evaluation Program tends to reinforce the expectations of continued uncertainty. Therefore the uncertainty about future regulatory certainty continues.

FIGURE III

NUMBER OF NRC REGULATORY GUIDES ISSUED
FROM 1970 TO 1984

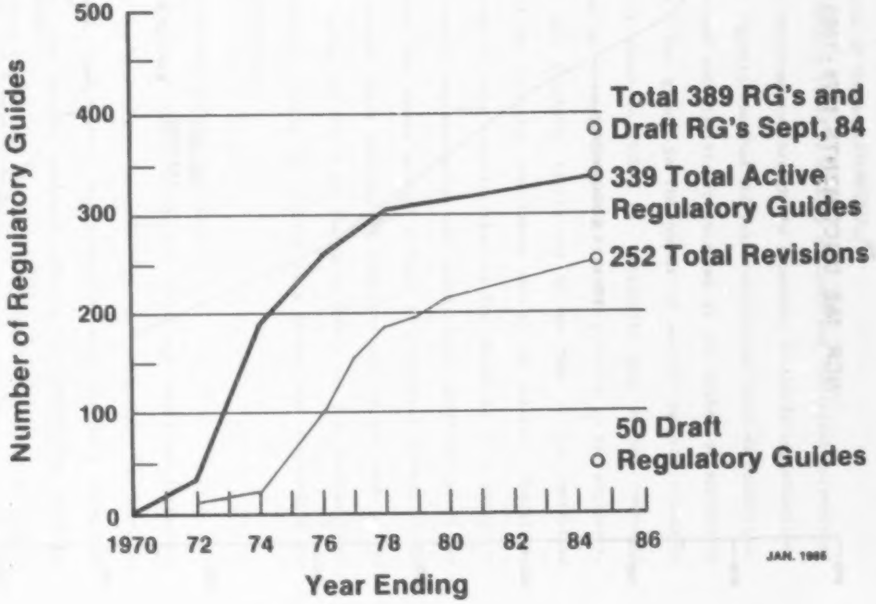
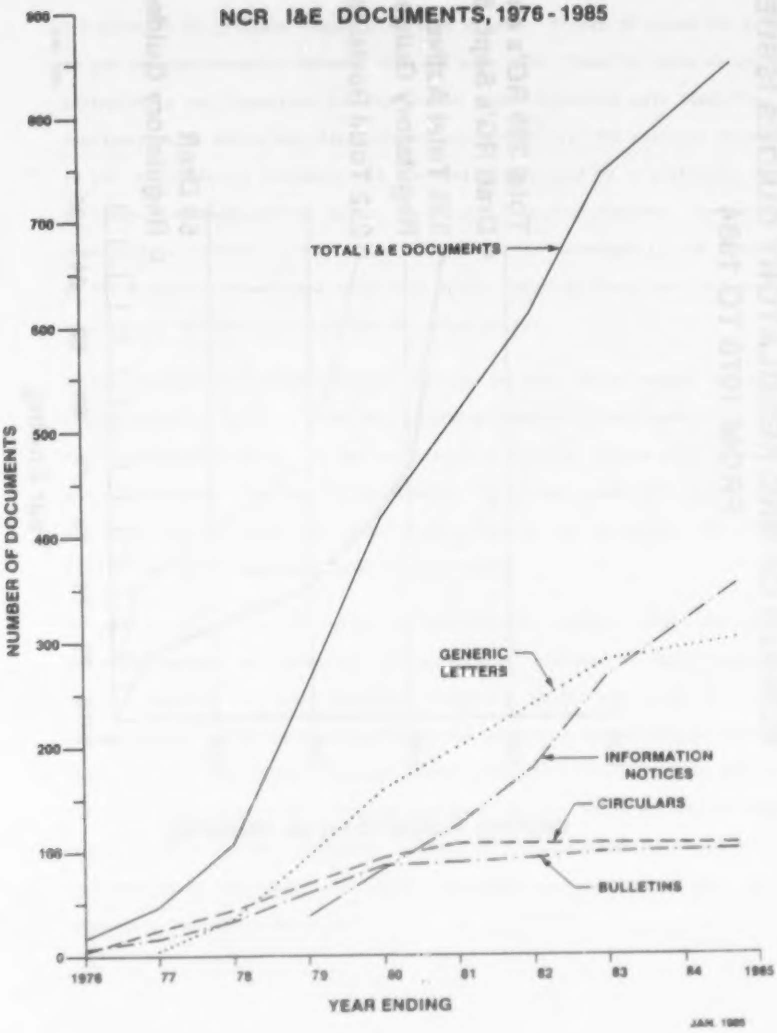


FIGURE IV



NCR I&E DOCUMENTS, 1976 - 1985

Number and Application of Consensus Standards

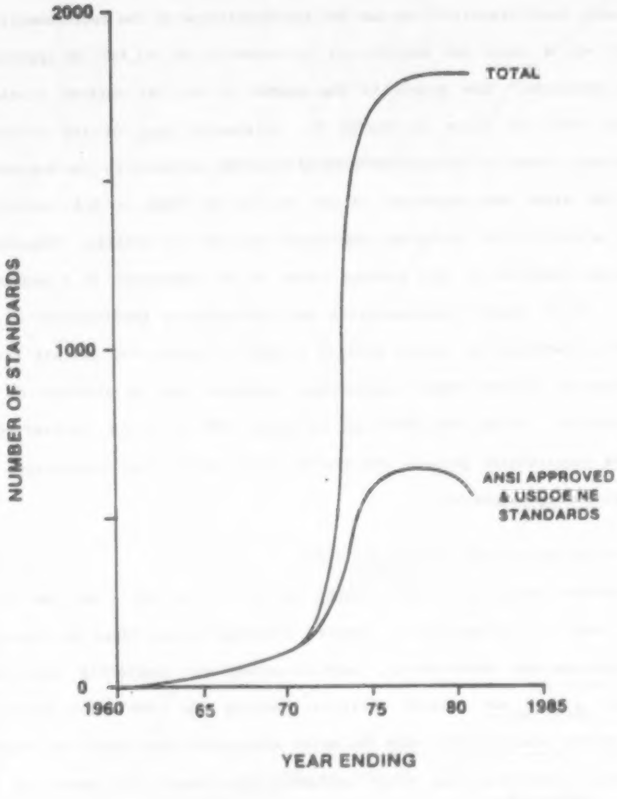
The nuclear power industry tried to develop guidance and consistent interpretation of the federal requirements through the consensus standards organizations. In some cases these organizations had NRC representation on the code committees. The result was a rapid and significant increase in the number of applicable consensus standards. The growth in the number of nuclear related standards during the 1970's is shown on FIGURE V. Originally most of the consensus standards were viewed as intended to provide flexible guidance to the engineers. But, the NRC views any standards called out in the PSAR or Q/A controlled documents as part of the licensing commitments made by the utility. Therefore, any standards involved in this context takes on the character of a mandatory commitment. As a result implementation and particularly modification of the use of these standards has become more of a legal or procedural process rather than a technical process where engineering judgement can be utilized as the basis for action. During the 1970's and the early 1980's the U.S. nuclear engineering and construction process has evolved in a manner that discourages the use of engineering judgement.

Emphasis on Seismology and Seismic Analytics

The U.S. nuclear regulatory climate during the 1970's and 1980's was characterized by a focus on low probability events. Principal among these has been the the evolution in the requirements, sophistication and complexity associated with seismic events and seismic analysis. During the 1960's the principal focus of seismic analysis was only the major structures that house and support the mechnical, electrical and other equipment associated with operating the plant. During the 1970's the scope has broadened significantly to include the mechanical equipment, piping, electrical and instrumentation systems.

FIGURE V

NUCLEAR INDUSTRY STANDARDS, 1961-1980



In addition, the sophistication and complexity of the analyses used has increased significantly. The emphasis on dynamic analysis resulted in endless reanalysis and rework as each change caused by a field interference affected the dynamic characteristics of the system and therefore required reanalysis to verify the seismic acceptability of the design. More importantly, the regulators and the industry have come to view complex analytics as a replacement for accepted practice based on decades of experience and testing.

Overly Conservative Interpretation of Standards & Regulations

The concern for a number of possible occurrences has resulted in U.S. utilities being extremely conservative in the interpretations of U.S Nuclear Regulations and associated consensus standards. The reasons include a desire to convince the NRC that the project is being prosecuted in good faith; the fear of being denied an operating license because designs defined in an early part of the project might not meet new requirements issued later during the construction process; and the fear of losing a decision in a regulatory or judicial hearing which would cause financial damage by extending schedule. Therefore there has been a tendency to overcommit during the licensing and design process; to accept requirements even though their financial consequences are severe and in general to seek levels of perfection and documentation which are unrealistic in terms of the normal field construction environment.

Extensive Interface Conflicts

The result of all these cross currents within the engineering and construction organization has been an extensive amount of interface conflicts. For example, the complex analytics used to support the licensibility of the plant call for installation precision and procedures that are extremely difficult in terms of the normal field construction environment resulting in endless reanalysis and increasing rework. The effort by the project to respond to the regulatory concerns for low probability events has increased interference problems by crowding containments and other Class I areas with seismic supports, pipe whip restraints and redundant systems. The results of these and many other examples has been a serious decrease in the productivity of manual and non-manual labor engaged in the engineering and construction of U.S. nuclear plants.

3. WHAT PROBLEMS DO YOU SEE AFFECTING THE OPERATION OF EXISTING PLANTS OVER THE NEXT 15 YEARS? OVER THE NEXT 30 YEARS?

I feel a sense of optimism about the prospects for improvements in operation of plants for the next 15 years. Irrespective of "panic surrounding the Three Mile Island event" and day to day negative press releases, it is important to note that with three decades of nuclear plant operation no person has been killed by such operation. This is to be contrasted to fatalities in commercial aircraft, highway, mining, industrial accidents, chemical plant releases e.g. Bophal, air pollution acid rain, etc. The unparalled safety record of the nuclear industry will, I believe be recognized with an improvement in public support and understanding. In this regard I believe the utility sponsored Committee for Energy Awareness will serve to improve public understanding and counter activist groups dealing in fear and misinformation. In some instances excessive costs have been incurred in nuclear plant construction in the name of safety with little or no net return.

Obvious problems effecting operations during this period will be an acceptable resolution of the waste problem both mid and long term. Depending on international stability increasing cost may be devoted to protection against terrorist activities this will not be confined to nuclear units.

In view of the excellent safety record of nuclear units I believe the problem of backfit and system redesign should be more carefully screened to maximize cost benefits.

The potential for intervention should be screened and minimized to prevent indiscriminate interference into operations.

4. WHAT PROBLEMS DO YOU SEE AFFECTING THE CONSTRUCTION OF NEW NUCLEAR POWER PLANTS?

The problems affecting the construction of new nuclear power plants is the perception of where we "the industry" are today. With a lack of conviction that the industry has solved its problems, no new nuclear power plants will probably be built.

A step beyond these questions is the hard reality of the utility and investment community perspective of nuclear power. This perception is, understandably, incredibly negative. The prospects of a utility's nuclear commitment in the U.S based on the status of the current uncertainties is hard to conceive. The current perspective is that the size is too big for todays perceived growth; the schedule is too long; the cost too high; and the uncertainties in terms of regulatory and licensing too great, and the financial threat too high in terms of cost exposure relative to net worth.

These problems may be offset by the conviction of some, standard design and pre-selected sites, advanced reactor concepts of smaller size with benign safety features may be the wave of the future. Examples of this include current EPRI sponsored studies of advanced LWRs and similar DOE sponsored work on advanced liquid metal reactor and gas cooled reactors. The smaller size is in tune with the expected slower load growth and desired minimal financial exposure for utilities.

5. WHICH OF THESE PROBLEMS ARE SUSCEPTIBLE TO LEGISLATIVE REMEDIES? HOW SHOULD SUCH LEGISLATION BE STRUCTURED? WHAT TYPE OF LEGISLATIVE CHANGES CAN IMPACT THE PROBLEMS PREVIOUSLY OUTLINED?

Before one can discuss the impacts legislative remedies can have on the industry, we need to have a set of goals with which to aim these remedies. For the nuclear industry (or in fact for any electric generating technology) to succeed in the future, the Technology should satisfy the following conditions in relation to existing technologies.

a. A less capital intensive plant, possibly smaller and modular in design

b. A shorter construction schedule

c. Testable for low probability events

d. Adaptable to more automation and robotics

e. Flexible in expansion to low load growth

f. Minimize site-related design i.e. site-specific characteristics

g. Regulatory participation

There are two types of legislation which will help satisfy these goals. The first is to provide funds to DOE for the purpose of developing new technology concepts which will satisfy the need for flexible and modular designs. This is not limited to nuclear power, since the financial and regulatory burdens impact coal technology as well.

The second type of legislation remedy is to coordinate and simplify the licensing of nuclear facilities. The voluminous set of regulatory document CFRs need to be screened and simplified so that the intent of the regulation are understood and implemented. We need a simpler process of screening regulatory activities to limit the extent to which changes in regulations will impact on plants already under construction. For many non-critical safety related areas, designs should be grandfathered under regulatory changes.

This legislation also needs to limit the extent of non-contributing intervenor actions. The actions taken by intervenors should only be allowed if they directly contribute to the safety of the public and the expectation of the utility's consumers (i.e. lowest cost generation).

Encompassing all these factors is the need for a more cooperative relationship between legislatures, NRC, PUCs and utilities. The existing adversary relationship impacts on overall costs and schedule length.

If the aforementioned goals can be met, the technology will be a viable, inexpensive form of generating electricity which will last into the forseeable future.

6. WHAT OTHER SOLUTIONS ARE THERE TO THESE PROBLEMS?

Considering that intervenors and the media seem to dominate negative news exposure to the public, implement a program to insure that truth and technical facts are given. Withhold federal support of activities and agencies not in compliance with the above.

APPENDIX A

SOURCE: "IMPACT OF REGULATORY INSTABILITY ON CALLAWAY"
(SECTION IV)

PREPARED BY

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CASE NO.: ER-84-168
MAY 3, 1985

IV. EFFECTS OF REGULATION

To understand the effects of regulation, it is necessary to review the changes in and the time sequence of those requirements that affected the cost of engineering, design and construction of nuclear power plants. The following review describes the evolution of nuclear power plant practice relative to the design of piping and structures, continuing changes in Regulatory Guides and other NRC "guidance" documents, and the design of electrical and I&C components. The review also discusses the impact of this evolution on the most significant cost drivers; engineering, field supervision, and craft labor content. The understanding gained from this review is then used to quantify, with the assistance of the EEDB resource, the changes in nuclear power plant cost over time attributable to changes in regulation.

In the beginning, nuclear power plant design borrowed heavily from the code requirements for building fossil plants and boilers. The reactor pressure vessel designs were guided by Section VIII of the ASME Boiler and Pressure Vessel Code, heat exchange equipment such as high pressure heaters utilized the Tubular Exchange Manufacturers Association guidelines, and structure design followed the Uniform Building Code.

The fossil power plant pipe design code for calculating stress flexibility under static loads was ANSI/ASME B31.1. The basis for the ANSI/ASME B31.1 code was design conservativism based on experience that set large margins for safety and allowable stresses in a static load system. That is, B31.1 did not look at the dynamics of piping systems or the details of lifetime transients and/or earthquakes. It looked at a much more fundamental and simplistic piping stress analysis based on decades of practical experience.

READEX FICHE

TABLE 4-1

SPECIFIC SEISMIC REQUIREMENTS FOR NUCLEAR POWER PLANTS

Code of Federal Regulations

CODE		REVISION DATES		
Number	**Title**	**R0**	**R1**	**R2**
10CFR50 Appendix A Criterion 2	Design Basis for Protection Against Natural Phenomena	7/62	5/71	7/71
10CFR100 Appendix A	Seismic and Geologic Siting Criteria for Nuclear Power Plants	12/73	1/77	—

Regulatory Guides

GUIDE		REVISION DATES			
Number	**Title**	**R0**	**R1**	**R2**	**R3**
1.12	Instrumentation for Earthquakes	3/71	4/74	----	----
1.29	Seismic Design Classification	6/72	8/73	2/76	9/78
1.57	Deisgn Limits and Loading Combinations for Metal Primary Reactor Containment System Components	6/73	----	----	----
1.60	Design Response Spectra for Seismic Design of Nuclear Power Plants	10/73	12/73	----	----
1.61	Damping Values for Seismic Design of Nuclear Power Plants	10/73	----	----	----
1.89	Qualification of Class 1E Equipment for Nuclear Power Plants	11/74	----	----	----
1.92	Combining Model Responses and Spatial Components in Seismic Response Analysis	2/76	----	----	----
1.100	Seismic Qualification of Electric Equipment for Nuclear Power Plants	3/76	8/77	----	----

In 1963, the ASME Boiler and Pressure Vessel code was modified by the development and initial issuance of Section III of the Code, which related solely to nuclear pressure vessels and their design and construction.

Between 1963 and 1971, the ASME III Code Editions and Addenda set forth added requirements for the pressure vessels which called for a much higher level of quality assurance and control than previously employed and required a much more detailed approach for the design analysis of the vessel. Similarly, the Nuclear Piping Code ANSI/ASME B31.7 set higher allowable stresses for nuclear safety grade piping, and required a much more intensive quality assurance program and a much more detailed analytical program.

Section III was intended to encompass the rigorous requirements for reliability necessary in the design and construction of nuclear pressure vessels only. Paralling the development of the requirements of Section III, the Nuclear Power Piping Section USAS B31.7 of the ASME B31 Piping Code was introduced for the nuclear piping associated with nuclear pressure vessels. The Winter 1969 Addenda to Section III referenced the provisions of B31.7 as well as the 1968 Edition of the ASME Code for pumps and valves for use in a nuclear power plant systems. With the intent of providing a single source of consistent rules for the construction, including analytical design for nuclear power plant components the 1971 Edition of Section III adopted and included the provisions of both B31.7 and the Pump and Valve Code.

In the early '70s, the Code of Federal Regulations set forth 64 general design criteria in 10CFR50 Appendix A for the design, construction and operation of nuclear plants, as well as 18 criteria for the documentation and quality control associated with nuclear plants. These same requirements are in effect today, are now accompanied by a host of interpretive documents which will be discussed later.

In the period 1971 to 1975, the fundamental concentration in design was on stress transients caused by fluids, loss of coolant accidents, and transients associated with start-up, operation, and shut-down, i.e., the consideration of temperature with pressure transients. This concentration led to very intensive analyses of the number of cycles the power plant experienced over its lifetime, which in turn led to the escalation in the analytics associated with QA requirements for the design of piping and pressure vessels.

At this time, earthquake analyses were required to include a response spectrum analysis in which the structures were analyzed with respect to the seismic ground motion in order to determine the structures' dynamic response to the frequencies and motions at various levels and locations in each plant structure. This information was then used to design seismically qualified equipment, piping, and supports for these levels and locations. In comparison, the early analyses of safety-related equipment and piping systems, as performed for the Dresden, Browns Ferry and Indian Point nuclear units, was done on a more simplistic static basis. Thus, during the early 1970's, the additional analytical requirements were judged to require approximately three times the level of manpower as was initially associated with the simplistic fossil power plant type of analysis used in the era of 1963 to 1970.

During the 1971 - 1972 timeframe that followed, the Winter 1972 Addenda of ASME Section III and the time history approach to the analysis of seismic inputs were introduced. The additional analytical requirements in the ASME Section III code integrated piping, vessels and structures into one code, ASME Section III, Divisions 1 and 2. Division 1 covered the mechanical pressure retaining components. Division 2 required the detailed design analysis of concrete reactor pressure vessels and containment structures to an extent and level similar to that applied to mechanical pressure retaining systems. The level of detail was beyond that associated with the designs of concrete containment structures of earlier years. This addition to Section III fundamentally brought the entire "nuclear island" under the umbrella of an intensive design set of requirements, which in earlier days applied only to the mechanical pressure retaining components of the system. The evolution and escalation of interpretation led to further intensification of analysis and increased the overall manpower requirements for such sophisticated analyses by another factor of 10 over that associated with early fossil power plant type of analysis.

An example of the effect of using the Section III approach as opposed to the earlier fossil power plant type approach is shown in the WASH-1082 comparison of Figure 4.1. The design approach under Section III actually permits use of higher stresses because of the use of materials having a higher degree of assurance of sound material due to the additional examination requirements. In other words, assurance of quality is substituted for margin to offset uncertainty. This approach permits a reduction in material thickness requirements. Analytics at the 1971-1972 point in history were generally confined to the main systems, namely the primary coolant systems, main feedwater steam piping and larger safety grade piping systems. Since 1975, however, there has been a continuing increase in items which have fallen under the umbrella of total Quality Assurance, total analysis and total documentation. This situation has evolved to the point where virtually everything that may be located within the safety boundary of the containment and auxiliary building, including the safety systems, has been included in an analysis of one kind or another. Such details as electrical systems, cables, heating and ventilating systems, instrument tubing, miscellaneous small equipment and safety related structures falls into this category. The analytical trend has grown to include time history analysis, fluid flow analysis, and dynamic analysis, concerning water hammer, as well as combined effects that influence even the smallest part of the overall containment system and the reactor pressure boundary.

In 1979, the nuclear power industry published supplementary quality assurance requirements in ASNI/ASME NQA 1 and 2 to interpret 10CFR50 Appendix B. This interpretation, in an effort to provide more specific guidance, promulgated requirements for analysis, record keeping, and inspection at a much more deatiled level than Appendix B. The result was less flexibility of interpretation and an increase in actual requirements to be met. Eventually, the interpretation effort expaned to give guidance for systems and equipment, other than safety-related, that had some level of "importance to safety." The ultimate result of this effort is reflected in the curent scope of Section III which is applicable to anything in a nuclear power plant. Consequently, all nuclear power plant systems and equipment now fall within the umbrella of safety-related quality assurance requirements in the ASME Boiler and Pressure Vessel Code - Section III.

Although the above ANSI and ASME documents are considered as "industry" standards, the standards committees included NRC/AEC staff members whom provided direct input and guidance. Thus the regulators were also contributing to the writing of industry positions.

It is important to note that what initially started out as a code applying only to a nuclear vessel has been put into the form of a document called ASME Section III and its Appendicies covering virtually all the mechanical elements of the plant having anything remotely to do with safety. The highly detailed rigorous approach to designing a pressure vessel to Section III Winter Addenda has escalated the overall mechanical design effort, which was initially judged to be 7,000-12,000 manhours, to currently 500,000-600,000 manhours and growing. The evolution of pipe, structures, and nuclear system design analysis manhours and cost is shown graphically in Figures 4.2, 4.3 and 4.4.

These facts form the main thrust of what we perceive to be the regulatory drivers which have contributed dominantly to regulatory increase in cost and, although pertaining to Section III of the Boiler and Pressure Vessel Code, it is really an extension of 10CFR50. We are not aware of anyone who anticipated the level of detail which would be applied as a consequence of this code extension. Within that framework, the design for very low probability events, such as earthquakes, were driven by regulatory interpretation and have contributed heavily to increased costs. This is true not only for engineering and design, but also for the increases in craft labor manhours and costs due to the complexity of erection and the associated resulting rework. It is difficult to prove that safety is necessarily enhanced because of the low probability nature of the events being analyzed.

Regulatory guides were originally designed to give guidance to applicants in meeting the 10CFR50 criteria and were not intended to be mandatory. In practice, however, the guides became mandatory requirements because applicants were faced with the burden of proof and attendant delays in the licensing process if they chose to resolve issues in ways which were different from those sponsored by the guides. Additionally, the regulatory review process was never able to effectively control the idiosyncrasies of individual reviewers' interpretation of the guides.

Regulatory guides were required to go through a strenuous in-house development and review process, followed by public review and comment period, followed by approval of the Advisory Committee on Reactor Safety. Additionally, the Commissioners were required to approve initiation of each project. Eventually,

FIGURE 4-2

PIPE STRESS ANALYSIS AND SUPPORT HISTORY

			1965		1970		1975		1980
REGULATORY REQUIREMENTS		National Promotion of Nuclear		AEC Requires Analysis of Crit. Sys.	AEC Requires Classification of Systems/ Analysis 10CFR50	3D Seismic Criteria 10CFR100 RG 1.92	Pipe Rupt. RG 1.46	Pipe Whip Jet Impinge 10CFR 50.55	Design for Operability 10CFR21
INDUSTRY CODES AND STANDARDS:		B 31.1		B 31.7		ASME III WINTER ADENDA ASME III		ASME III NF	
PROJECT DESIGN APPROACH:		Manual Calc. for Flexibility Static Analysis		Manual/Computer Critical Lines Dynamic (Response Spectrum)		Time History	Finite Element Time History (Seismic, Fluid Flow)	Waterhammer & Steamhammer Non-Linear Dynamic	
DESIGN COST IMPACT	Manhours:	7,000-12,000		30,000 - 40,000		150,000 - 172,000		500,000 - 600,000	
	Computer:	$10,000		$50,000		400-500,000		$3-4 Million	

SOURCE: Adapted by UE&C from a figure in a paper entitled "A Brief History of Pipe Stress and Supports in the Nuclear Industry", presented at an ANS conference by Mr. D. F. Shave of Stone & Webster; adaptation consisted of modifying headings on left hand side.

FIGURE 4-3

CATEGORY I STRUCTURES
ENGINEERING AND DESIGN (EXCLUDING SUPPORTS)

	1965	1970	1975	1980
REGULATORY REQUIREMENTS			**10CFR50, 10CFR100** **RG 1.60, 1.61, 1.92; SRP 3.5, 3.7,**	**Nonstructural requirements which impact structural work, e.g. fire protection, separation, etc.;**
INDUSTRY CODES AND STANDARDS:		**ACI 318**	**ASME Section III, Division 2**	**ACI 349**
PROJECT DESIGN APPROACH:		**Hand Calculation** **Coefficient for Seismic Design**	**Computer Solutions Finite Element Method Anistrophic Modelling of Concrete** **Response Spectrum and Time History Seismic Analysis**	**Finite Element Soil Structure Interaction Analysis**
DESIGN COST IMPACT Manhours:	100,000	200,000	500,000	1,000,000
Computer:	$10,000	$100,000	$1 Million	$2 Million

SOURCE: UE&C, 7/1/82

FIGURE 4-4

ENGINEERING & DESIGN
NUCLEAR DISCIPLINE

		1965	1970	1975	1980
REGULATORY REQUIREMENTS	Atomic Energy Act 1954	10CFR50 Appendix B 7/27/70	Reg. Guides Brown's Perry Fire	Appendix A on Fire Prot. TMI	NUREG-0588 NUREG-0800 APPEND. R NUREG 0612
INDUSTRY CODES AND STANDARDS:	Section VIII TEMA	Section III Div. 1	Section XI N45.2 IEEE STD's Sect. III Div. 2	NQA-1	NQA-2
PROJECT DESIGN APPROACH:	Manual Calc. Fluid Flow & Heat Trans. Simplified Rad. Dose Calc.	Exicement & U-F Solid Waste	QA Program & Procedures	Document All Design Changes	Ex: Crystalizer Extruder Asphault Solid Waste Calc: Computer
DESIGN COST IMPACT	Manhours: 1-2 x 10^5 Computer: 0.5 Million				Nuclear 1.5×10^6 \$6 x 10^6

the process became so formalized and rigid that the regulators were effectively promulgating mandatory requirements without the benefit of following agency rulemaking procedures set up by law. To offset challenges to the process, the agency has recently substituted the rulemaking process for issuance of regulatory guides. Formal rules have the force of law and overcome the objections to promulgating mandatory requirements outside the rulemaking process. However, the effect is the same; flexible guidance has been replaced with rigid rules and a process where the only recource of not following the "guidance" is to object through the courts. However, this can lead to costly project delays.

Since regulatory guides fail to provide the guidance needed by applicants to interpret the criteria in 10CFR50, both the industry and the regulators moved to find other means of assistance. The regulatory agency invented the formal branch technical position. The branch technical position was an effort to cause safety analysis reviewers to provide consistent interpretation of the agency's rules and regulations; i.e., interpretation of 10CFR50. Branch technical positions are now included in Standard Review Plans which fill three large volumes of documents printed in closely-spaced type on both sides of each sheet. This effort has not removed the uneven approach of individual reviewer interpretation. Other methods used by the regulators to provide guidance and foster consistency in interpretation was to add more appendices to 10CFR50. Currently there are fifteen very detailed appendices covering quality assurance, radiation release, fire protection and many other subjects, but this additional guidance has not solved the problem of even interpretation of 10CFR50 criteria.

In addition to ASME codes and regulatory guides, the nuclear power industry supported promulgation of voluntary consensus standards. As with the ASME and ANSI standards, NRC/AEC staff members played an integral part of many of the standards committees in providing direct input and guidance. One of the first of these was IEEE (Institute of Electrical and Electronic Engineers) Standard 279, "Proposed IEEE Criteria for Nuclear Power Plant Protection Systems" published in August, 1968. This standard promulgated the single failure criterion and the requirements for equipment qualification, protection from environmental events (e.g., earthquake), channel integrity and independence, and completion of a protective action, once initiated. 10CFR50.55a, paragraph (n) invoked this standard and its successor as law in July, 1971. This standard was revised in June, 1971 to clarify the criteria and add a requirement for development of a specific design basis for each protection system. Nevertheless, specificity was still deemed to be lacking and additional guidance on interpretation was needed.

In July, 1970, IEEE Standard 308, "IEEE Standard Criteria for Class 1E Electric Systems for Nuclear Power Generating Stations" was approved. This standard established a safety classification system, identified the concept of design basis events, and promulgated requirements for power quality, identification, equipment protection and qualification, redundancy, independence and failure modes and effects analyses. In April, 1971, IEEE Standard 323, "IEEE Trial Use Standard: General Guide for Qualifying Class I Electric Equipment for Nuclear Power Generating Stations" was approved. This standard promulgated requirements for equipment qualification to expand on the requirements set forth in IEEE Standard 279 and IEEE Standard 308 and the equipment quality requirement of 10CFR50 Appendix A. IEEE Standard 323 was revised in February, 1974 to expand and clarify the abbreviated criteria of the 1971 version and to introduce the concept of pre-aging qualification test samples to the end of their useful life prior to being type-tested to perform their safety function under design basis event conditions. This concept is and has been state-of-the-art and has been a very difficult issue for both the regulator and the regulated.

In the electrical area, the IEEE has generated over 100 nuclear-related standards or revisions to these standards since the first four mentioned above were developed in the early 1970s. Some of these standards have had a major impact in expanding the original concepts promulgated by 10CFR50, Appendix A, into wider application.

IEEE Standard 323 spawned a series of qualification standards for specific applications. The concepts of environmental qualification and aging were extended in detail to applications for motors (1971, 1974), valve operators (1972, 1980), cables (1974), modules (1977), battery chargers (1980), motor control centers (1980), station batteries (1980), and static inverters (1980). Additionally, a special qualifications standard on seismic qualification was developed (1971, 1975). In 1980, IEEE Standard 627 "Design Qualification of Safety Equipment Used in Nuclear Power Generating Stations" was approved. This standards project was a joint effort of IEEE, the American Society of Mechanical Engineers, American Nuclear Society, the Instrument Society of America and the American Society of Civil Engineers. The standard extends the requirements for environmental equipment qualification and aging beyond electrical equipment to all structures, systems and components.

In 1977, IEEE Standard 603, "Trial Use Criteria for Safety Systems for Nuclear Power Generating Stations" was approved. This standard extended the requirements of IEEE Standard 279 for protection systems to safety systems, which include protection systems, actuation systems and their auxiliary supporting features. This document was made a full status standard in 1980.

Many other subjects have been addressed in the effort to provide guidance in interpretation of the regulatory requirements. Among these are periodic testing (1971, 1975), reponse time testing (1977), quality assurance (1971, 1975, 1980), separation and independence (1974, 1977, 1980), reliability (1975) and many others. Additionally, efforts are under way to produce new standards in the areas of control rooms, human factors, reliability, equipment classification, pre-operational testing and associated subjects. The evolution of Engineering and Design for Class 1E electrical systems is shown on Figure 4.5.

Figure 4.6 illustrates a dramatic increase in the number of industry standards and regulatory requirements applicable to safety systems instrumentation and controls (I&C) since 1970. These new standards and regulatory requirements have led to extensive changes in safety systems I&C, including hardware replacement. Each time changes are required, new or revised specifications, system descriptions and drawings must be prepared and reviewed. Typically, further revision is required to address reviewer comments. Many manhours are required, usually manhours not included in the existing budget. One way to illustrate the nature of safety system I&C changes is to take a "snapshot" of the instrumentation and controls provided in different years.

In 1972, I&C safety systems consisted of the reactor protection system (RPS), the safety features actuation system (SFAS), I&C required for safe shutdown, and I&C required to monitor and control the safety features.

The RPS and SFAS were unique in that they consisted of redundant sets of electronic instrumentation cabinets, sensors and actuation devices. These systems were designed in accordance with IEEE-279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations," past experience, and good engineering judgement. AEC (predecessor to NRC) guidance was limited to the General Design Criteria (GDC) of 10 CFR 50, Appendix A.

A new category of I&C evolved in 1975—"safety-related." Safety-related I&C were designed to meet the single failure criterion of IEEE-279-1971 as well as the following IEEE standards:

IEEE Standard	Title
323-1971	General Guide for Qualifying Class I Electric Equipment for Nuclear Power Generating Stations
344-1971	Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations

Other new standards applied; however, IEEE-323-1971 and IEEE 344-1971 had the most impact. In order to meet these criteria in the simplest way possible, safety related I&C were relocated to new panels, usually two, designed to comply with these criteria. The reason for two panels was that two independent safety trains are necessary to meet the single failure criteria, i.e., failure of Train A could not affect operation of Train B and vice-versa.

The scope of "safety-related" I&C included equipment required to maintain safe hot shutdown from inside or outside the control room. To accomplish this, additional safety-related panels were provided outside the control room. In addition, main steam and feedwater isolation valves were provided which closed automatically by steam line break instrumentation and controls either in the form of new safety features or new safety-related I&C.

Furthermore, to provide the physical and electrical isolation required by Regulatory Guide 1.75, "Physical Isolation of Electrical Systems," fiber optics and optical isolation were employed in the reactor protection system, safety features actuation system and in safety-related I&C. In some cases this change was accomplished by replacing a first generation system with a second generation system.

The new standards required extensive qualification programs which included testing for stringent environmental conditions such as high temperatures, pressures, and radiation, as well as aging. Although these qualification programs did not increase the I&C quantities, they are expensive state-of-the-art requirements that significantly increased component costs.

As late as 1982 numerous changes were underway or made as a result of the TMI incident and the following regulatory documents:

Document	Title
NUREG-0696	Emergency Operational Facilities
NUREG-0737	Post TMI Requirements
R.G. 1.97, Rev. 2	Instrumentation for Light-Water Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident

Examples of the impact on I&C is that the following additional design features are required:

1. Emergency Operation Facility
2. Technical Support Center
3. Human Factors Review of Control Room and Subsequent Panel Redesign
4. Modifications to Improve Reliability
5. Post Accident Monitoring Instrumentation Qualified to LOCA (Loss of Coolant Accident) and SLB (Steam Line Break) Containment Environment For Duration of Accident
6. Reactor Coolant System Vents
7. Plant Safety Parameter Display (SPD) Console
8. Post Accident Sampling
9. Auxiliary Feedwater Evaluation
10. Instrumentation for Detection of Inadequate Core Cooling

The quantification of the I&C regulatory requirements is shown in Figure 4.6.

The preceding Figures 4-2 through 4-6 graphically show the history of the evolution of those requirements which we believe to be fundamental cost drivers. As outlined in the previous pages, they have been applied in the last fifteen years with ever increasing requirements of detail and analytical design manpower. In turn, they have continued to increase manpower for nuclear plant construction as evidenced by a variety of data and analysis obtained from numerous utilities.

Quantification of Cost Drivers

The "ripple effect" caused by escalating regulations, codes, and standards has continuously resulted in large variances between initial cost estimates of meeting regulatory criteria and the final cost impact. "Ripple effect" is an expression derived from the analogy of a stone thrown into water which results in a series of waves which spread further and further from the initial point of impact. Similarly, a new requirement for installation of a component such as a valve in a nuclear plant can result in interferences which require relocation of other components and their seismic supports, which in turn require reanalysis and redesign of numerous other systems and their supports. Thus, estimates of the economic effects of a new regulatory requirement have been in error by factors in excess of 1000. Estimates of the regulatory and standards economic impact have consistently been substantially lower than the results realized.

As has been highlighted in earlier sections, the fundamental cost drivers effecting the Callaway unit, as well as experience across the U.S., are as follows:

1. Increases in commodities
2. Increases in the unit cost of commodities
3. Increases in field direct and indirect labor
4. Increases in engineering labor both home, office and field
5. Increases in miscellaneous services, purchasing, QA, clerical, reproduction, printing, mail, and transportation.

6. Increases in time related costs to escalation and interest
7. Increase in owners' expense as driven by the above.

Of the above cost drivers, our evaluations of regulatory cost impact over the last ten years show that increasing manpower requirements for engineering, design and construction is the major cost driver which, except for time related costs, is the most significant contributor to increased nuclear power plant cost. The manpower related cost have increased by factors of 3 to 4. This is due to the labor intensity of nuclear plant construction and the increase in labor manhours to do the job. This increase in the required manpower cannot be explained as a simple function of commodity content because commodity content was reasonably stable during the timeframe 1976 to 1982. Fairly large commodity increases occurred earlier in the 1968 to 1976 timeframe.

The effective use of manpower has been negatively impacted by evolution in regulatory interpretation for the following reasons:

a. Increasing depth of analysis relating to low probability events, e.g., earthquake
b. Increasing depth of detail in developing engineering information to document elements of the smallest detail where safety may be an issue
c. Redundant analysis and design verification
d. Redefinition of design analysis techniques
e. Increase in field construction manpower per unit of work accomplished due to QA, crowding, the complexity of nuclear plant construction, and backfit requirements.*
f. Increases in commodities, equipment and materials

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*A good illustration of backfit costs can be found in the 3/21/83 letter from W. Council (Northeast Utilities) to J. Tourtellotte (NRC). This letter addresses productivity, documentation, regulatory inconsistencies and incompatible requirements, and documents the high cost of imposed backfits.

In the Callaway timeframe of 1976 to late 1982, the quantity of commodities has remained relatively stable for the industry, see Figures 3.2 and 3.3, However, examinination of the Callaway Major Installed Quantities on Table 4-2 indicates that, although quantities are stable, productivity has deteriorated (i.e. manhours per unit of work) for several types of commodities including; rebar, concrete, structural steel, small pipe hangers, large pipe hangers and conduit. UNITED believes that the reasons for this productivity decline are directly related to the increase in regulations, regulatory guides and I&E bulletins which the industry has been responding to on a continual basis.

Westinghouse's Water Reactor Division has been maintaining a historical file of Regulatory Criteria that effects nuclear power plants. Figure 4.7 graphically portrays the spurt of regulatory criteria which occurred during the initial stages of the Callaway project, 1973 to 1976. Callaway was subject to these criteria even though full interpretation of the criteria were not necessarily defined. Furthermore, since many of these criteria were state-of-the-art, no body of practice had been established which would assure that the criteria were uniformly implementable and enforceable, or would indicate what problems might result from their implementation. The accuracy of the "Definitive Estimate" would certainly be effected by the level of understanding for the more recently envoked criteria. The invoking of additional criteria has continued through the life of the project so that the scope of the project has continually changed since its very inception. To measure the effect of scope change has proved difficult for Union Electric and the industry at large because utility accounting systems were not designed to measure and categorize changes as a function of a requirement's issuing agency or organization.

The Advanced Engineering Department of United Engineers & Constructors Inc. has maintained an analysis of cost trends utilizing consistent reporting over a span

Reference Item 3 #1

TABLE 4-2

MKF/MJK
January 31, 1984

Summary of Major Installed Quantities
(Powerblock)

	U/M	Definitive Est. Unit Rates	Definitive Estimate	11/29/83 Projection	Projected Unit Rates
Formwork & Metal Decking	SF	0.899	1,465,348	1,492,338	.822
Rebar	TN	30.37	12,933	12,772	74.97
Concrete	CY	2.36	122,602	123,489	8.37
Structural Steel	TN	17.42	10,391	9,800	43.63
Small Pipe	LF	4.30	126,000	138,982	6.39
Small Pipe Hangers	EA	16.23	22,836	15,727	49.25
Large Pipe	LF	6.52	140,579	260,201	5.74
Large Welds	EA	21.10	9,253	16,433	27.90
Vendor Pipe	LF	1.22	22,030	31,883	1.66
Large Pipe Hangers	EA	57.75	8,380	11,387	128.13
Instrumentation	EA	11.55	4,510	3,688	8.41
Lighting Conduit	LF	1.17	105,000	117,204	1.32
Communications Conduit	LF	.75	61,000	43,728	1.72
Power Conduit	LF	1.15	211,240	248,362	3.76
Cable Tray	LF	1.45	73,600	82,860	2.11
*Wire & Cable	LF	.107	3,832,300	4,334,691	.084
*Terminations	EA	.95	94,323	138,141	1.13

* Includes ESWS

of 17 years, 1967 to 1984. We have maintained a catalogue of changing regulatory and code & standard requirements over the years. However, neither we at UNITED nor any other group that we are aware of has maintained a satisfactory accounting type inventory of the detailed cost impact of changes in requirements induced by the NRC or the consensus standards groups.

The underlying forces which made labor content and other items cost drivers for nuclear power plants are understood in a qualitative manner and the attempt here is to quantitatively associate the cost driver with the underlying forces.

United Engineers has conducted capital cost studies for nuclear power plants from 1967 to the present for the Department of Energy and its predecessor organizations. UNITED currently maintains the Energy Economic Data Base for DOE now in its seventh update. The data base has been updated yearly since 1978 and was preceeded by capital cost studies for large nuclear and fossil plants in the mid-1976 timeframe. The updates of the studies since 1976 have been conducted on a consistant basis moving the cost and regulatory base dates through time.

The data base cost estimates are based upon a detailed technical model which includes system design descriptions for up to 400 systems, a detailed equipment list contianing up to 1200 equipment mini-specifications and up to 10,000 lines of material and equipment quantities, labor hours and costs. The technical models are based on actual power plant designs and over 50 years of power plant design and construction experience. This experience has been supplemented in recent years with periodic technical and cost surveys of public and proprietary information and with parallel DOE studies to establish benchmarks against which the EEDB results are measured. Site related factors are normalized by locating each technical model on a common hypothetical "Middletown" site, for which there is a detailed geological and environmental description. The EEDB user may make credible comparisons among alternates based on the data as presented.

Taking the 1982 data base EEDB-V, and discounting the cost of safety related structures, systems, and materials to the mid 1976 timeframe (with the GNP deflator) yields scope increases in the range of 4 to 7% per year, see Table 4-3. This matches closely the yearly cost increase for equipment, material and subcontracts for Callaway.

In similar fashion, the engineering costs (Accounts 92-Home Office Engineering and 93-Field Office Engineering) of the Data Base were discounted to the 1976 timeframe in Table 4-4. The yearly increase for engineering costs from the data base ranges from 13 to 21% annually. The Callaway cost increase for engineering have moved in a range of 19 to 29% annually, although the total hours for Callaway are less than the industry average due to the SNUPPS arrangement.

The analysis of removing inflation is an attempt to quantify the effects of regulations in terms of constant dollars. When general inflation is removed from the 1982 data base the resulting cost differences between the 1976 analysis and the deflated 1982 data base are the effects of regulation. Since, the Callaway data for the definitive estimate and the current estimate reflect cost increases very similar to that encountered by the industry as a whole, we are inferring that the the difference in constant dollars with inflation removed is due to regulatory changes.

This analysis of cost adders due to changing regulations and their interpretation using the EEDB can be separated into the basic components of materials and equipment, engineering, and construction labor staff and home support, with the

TABLE 4-3

PWR - NPGS

SAFETY RELATED STRUCTURES EQUIPMENT AND MATERIALS
($ x 10^6)

ACCOUNT NUMBER	NAME	1982 DATA BASE	1982 DATA BASE DEFLATED TO 1976	1976 DATA BASE	MULTIPLIERS	% PER YEAR
21	Structures & Improvements	166	103.8	73.6	1.41	5.5
22	Reactor Plant Equipment	65.9	41.2	31.9	1.29	4
23	Turbine Plant Equipment	13.2	8.2	8.5	.96	-(.6)
24	Electrical Plant Equipment	31.9	19.9	14.9	1.34	5
25	Miscellaneous Plant Equipment	1.4	.9	.6	1.5	7
26	Main Cond. Heat Reject System	0		0	0	0
2	TOTAL DIRECT COST					

TABLE 4-4

PWR - NPGS

HOME OFFICE AND FIELD OFFICE ENGINEERING
($ x 10^6)

ACCOUNT NUMBER	NAME	1982 DATA BASE	1982 DATA BASE DEFLATED TO 1976	1976 DATA BASE	MULTIPLIERS	% PER YEAR
921	Home Office Services	245.5	153.4	45.8	3.35	21
922	Home Office Q/A	10.5	6.6	2.2	3.00	20
923	Home Office Const. Mangmt.	4.5	2.8	1.3	2.15	13
92	Home Office Engrg. & Serv.	260.5	162.8	49.3	3.30	21
931	Field Office Expenses	9.0	5.6	3.0	1.87	10
932	Field Job Supervision	105.3	65.8	18.4	3.58	22
933	Field QA/QC	8.9	5.6	4.5	1.24	3
934	Plant Startup & Test	4.5	2.8	2.7	1.04	.6
93	Field Office Engrg. & Serv.	127.7	79.8	28.6	2.79	18

Callaway cost increases compared to the data base as follows:

Category	NUREG to EEDB-V United Engineers	Table 4-4 Union Electric
A. Engineering	380	253
B. Materials, Equipment	149	219*
C. Construction Labor Staff & Home Office	422	303
	951	775

*Includes subcontract labor, approximately \$50 x 10^6

It should be noted that owners' cost, contingency and AFUDC are not included in this comparison. Also of importance is the relatively lower cost of engineering for Callaway resulting from the SNUPPS approach, which results in more effective use of engineering manpower.

Comparison of Callaway to the industry data correlates quite well in evaluating major cost drivers.

APPENDIX B

SOURCE: "CONSTRUCTION - WHAT THE USA CAN LEARN FROM FRANCE
ABOUT KEEPING COSTS UNDER CONTROL

BY

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ADVANCED ENGINEERING DEPARTMENT
UNITED ENGINEERS & CONSTRUCTORS INC.

FOR "NUCLEAR ENGINEERING INTERNATIONAL"
JULY 1985 ISSUE

Construction

What the USA can learn from France about keeping costs under control

By John H. Crowley and Robert S. Kaminski

Although the trend in the average cost of constructing LWRs in the United States continues relentlessly upward, the experience of the French nuclear industry, coupled with that of certain US units (see next article), suggests that significantly lower average plant costs would be achieved if there were licensing reforms which led to regulatory stability and encouraged standardization.

During the last decade and a half, the capital cost of the average US nuclear power plant has increased at a compound annual growth rate in excess of 20 per cent. This represents for the average US LWR a real escalation rate of 10-15 per cent per year, although a select few US LWRs, such as the Commonwealth Edison and Duke Power units, have escalated at a much lower rate. In contrast, the French nuclear plant construction programme has exhibited an average real escalation rate of only 4.4 per cent a year during the 1974 to 1984 period.

The US Department of Energy (DoE) and its predecessor agencies have been tracking nuclear construction costs, with assistance from United Engineers & Constructors Inc (UE&C), since the late 1960s. This effort has resulted in the development of an engineered methodology for cost estimating and a large data base of power plant economic models*. The data base is known as the US DoE Energy Economic Data Base (EEDB). The methodology underlying the data base has been documented and was discussed in an earlier issue of *NEI*[1].

In addition to the DoE efforts, the Electric Power Research Institute (Epri), with the assistance of UE&C, has been comparing the LWR construction programmes in the United States, France and other countries with the intention of identifying factors associated with variations in performance[2]. These efforts, coupled with UE&C's regulatory reform studies for the US DoE form the basis for the material presented here, although the thoughts presented reflect those of the authors alone.

US experience[3]. The value of the EEDB lies in the historical set of normalized-power plant models, which facilitate the identification of trends in the design and construction of nuclear and coal plants. In addition, the methodology used in the development of each model permits an analysis of the changes in cost, quantities of construction materials and labour manhours.

The DoE/UE&C EEDB programme has recorded persistent, occasionally dramatic increases in LWR capital cost estimates, see Fig 1. Analysis of the trends reveals that the dramatic increases derive principally from the instability of the US nuclear regulatory environment. This situation causes non-NSSS (nuclear steam supply system) related materials, and particularly manpower, to dominate the plant's total base construction cost. The problem is

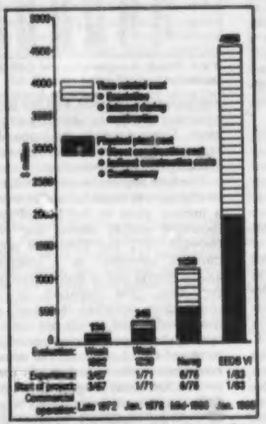
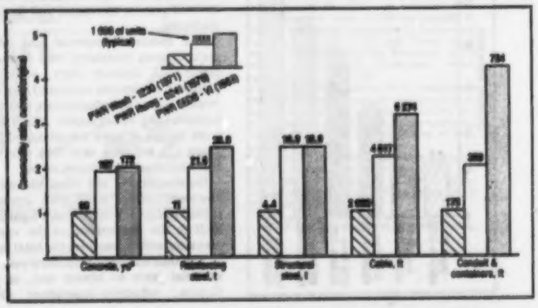


Fig 1. Plant investment cost estimates for a single 1000MWe US nuclear unit. Dollars are those at year of commercial operation. The "experience" date is the cut-off date for the regulatory requirements on which the cost estimate is based.

Fig 2. Comparison of construction material requirement for a US PWR, 1971-1983. The commodity ratio (vertical axis) is the ratio of current (1983) requirement to the original (1971) requirement.



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*The authors will be happy to provide references for the extensive documentation available describing both the methodology and the data base of the power plant economic models.

further compounded by the impact of extended schedules and higher inflation rates on the time-related cost of money.

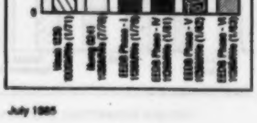
Construction material requirements or "commodities" are not in themselves a substantial portion of the base construction cost for US LWRs. They do, however, have an impact on the labour requirements. US LWR commodities have increased substantially in the last decade, Fig 2. Between 1971 and 1983 construction material requirements increased at compound annual growth rates of between 5 and 12 per cent depending on the material. In the late 1960s, construction materials and equipment were a significant portion of US LWR capital costs. By the late 1970s and early 1980s they had become a much smaller portion. Labour, both craft and non-craft, and time related factors have become the most significant portions of the total construction cost.

The manhours required to engineer and to construct a US LWR have also increased dramatically during the last decade and a half. The craft labour requirements for a US PWR increased at a compound annual growth rate of approximately 13 per cent between 1971 and 1983, Fig 3.

The increases in engineering and field service manhours have been even more dramatic. Between 1971 and 1983, the engineering and field service manhours increased at a compound annual growth rate of approximately 24 per cent, Fig 4.

It should be noted that most of the material and labour increases involve facilities and systems not supplied by the NSSS vendor. Rather they are associated with the envelope that surrounds and integrates the NSSS with the turbine generator and the surrounding environment. This is normally the scope of the engineering organization responsible for designing the entire plant.

Fig 3. Trends in craft labour manhours for a US unit.



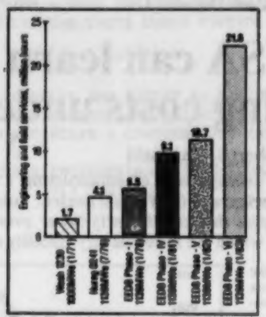


Fig 4. Trends in engineering and field service manhours for a US unit.

The time required to plan, to licence, to engineer, to construct and to start up a nuclear plant in the United States increased sharply during the 1970s. Between 1972 and 1980, the project duration increased at a compound annual growth rate of approximately 6.4 per cent. The duration of pre-construction activities increased at a compound annual growth rate of 7.0 per cent, while the construction period itself increased by 6.6 per cent. The schedule extensions reflect increased licence preparation time; longer NRC review time; larger engineering efforts because of evolving regulatory criteria; larger construction efforts because of increasingly complex and congested designs; and Three Mile Island (TMI) backfit requirements. Actual plant schedules are frequently longer because of additional utility-imposed delays caused by load growth reduction and financial problems.

The increased material and labour requirements translated into increased direct and indirect costs, while the schedule extensions increased the time related costs, namely interest and escalation during construction. All of these costs increases were compounded by a rising US inflation rate that drove up the escalation and interest rates.

Consequently, the total capital investment cost of a US LWR increased substantially; and there was a significant shift in the importance of the various elements which comprise the total cost.

The shift has been from hardware and material costs to labour and, in particular, schedule-dependent costs. About 60 per cent of the cost of a US LWR becoming operational in 1973 was composed of equipment and field material costs. Only 40 per cent consisted of labour and time-related costs. During the last decade, this composition has shifted in a manner that has caused labour and time-related costs to become around 70 per cent of the total capital investment cost for plants becoming operational in 1983.

The preceding discussion is based on the DoE/UE&C EEDB models. There is, however, a wide range in the actual cost of US LWR units.

US regulatory environment. In general, the deterioration in US LWR construction performance results from the current US nuclear regulatory structure and resulting environment.

The current regulatory structure has created an unworkable situation in which Nuclear Regulatory Commission (NRC) and industry staffs interact in an effort to obtain the goals of "zero risk" and "zero defects" within an adversarial and legalistic regulatory environment. The US regulatory environment has been unstable during the last decade and a half with respect to the promulgation of new legislation and safety requirements, with substantial growth in regulatory related documents during the 1970s and 1980s, Figs 5 and 6.

The importance of this evolution in regulatory requirements lies in the fact that the US regulatory system does not "grandfather" regulatory criteria as a function of some pre-construction licensing date. Consequently, plant design is subject to regulatory initiated changes during the entire licensing, engineering, construction and start-up process. This is a significant element in the deterioration of the US LWR construction industry.

The lack of a grandfathering feature in the US regulatory structure would not be important if the regulatory re-

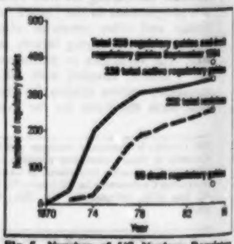


Fig 5. Number of US Nuclear Regulatory Commission regulatory guides issued from 1970 to 1984.

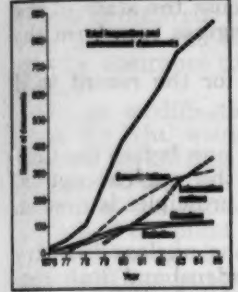


Fig 6. Number of US Nuclear Regulatory Commission inspection and enforcement documents, 1976-1985.

quirements remained relatively stable. Unfortunately this has not been the case. As a result a US LWR construction project is in a state of constant change from the date of docketing by the NRC until the operating licence is issued.

In addition to the direct impact of specific regulatory changes, the magnitude and character of regulatory involvement in a US nuclear construction project is such that it severely complicates and aggravates the normal problems encountered on any power plant design and construction effort. The instability problem has been compounded by the attempts of the US nuclear power industry to develop guidance and consistent interpretation of the changing federal reuirements through the US Consensus Standards Organizations. The growth in the number of nuclear related standards in the 1970s has been dramatic.

French experience. French LWR construction experience has been more favourable than that in the United States.

Between 1974 and 1984 the capital cost of French nuclear units, when measured in constant Francs, increased at a compound annual growth rate of approximately 4.4 per cent[4]. This is to be contrasted with the 10-15 per cent real escalation rate experienced by US nuclear units. The French attribute the 4.4 per cent real escalation rate to increasing regulatory requirements; increasing site related expenses incurred because the "easier" sites grew more scarce; and a residual drift associated with the character of nuclear construction that "... has some components which evolve faster than the general rate of inflation"[4].

Analysis of actual construction times for French 900MWe PWRs showed an average total improvement of 10-20 per cent between 1974 and 1980 as opposed to the steady deterioration characterizing US nuclear units, Fig 7.

An important element in the lower cost of the French units appears to be a significantly lower labour content, Fig 8.

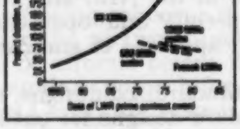
Lessons learned. The favourable French political attitude towards nuclear power[4], coupled with the integrated government/utility structure has led to a more stable and predictable regulatory environment[2]. This environment is characterized by the introduction of the grandfathering concept into the regulatory approach. This in turn facilitates and encourages plant design standardization.

The French have further enhanced the standardization option by using the government/utility structure to encourage standardization to the extent of having a single supplier for the NSSS and all other plant equipment. In the United States, there are 64 utilities with nuclear projects, four NSSS vendors, 14 architect engineers and five turbine generator manufacturers.

The Epri/UE&C study of selected US and French plants indicated that US utilities which attempted to standardize plant designs had achieved some savings, particularly with respect to labour utilization, because of the learning experience. But the continuous evolution in the number and severity of US regulatory requirements during the execution of the projects produced an instability and uncertainty that discouraged the standardization effort.

The result is that standardization efforts by US utilities should be characterized as a "point of departure" approach to design and construction rather than as true standardization. These utilities have enjoyed some success because the "point of departure" approach enabled their projects to focus on controlling change. This in turn helped to minimize the impact of the unstable US regulatory environment on the projects.

Fig 7. Comparison of US and French actual or expected project durations for LWRs referenced to prime contract award date.
Note: LWR project duration is taken as the time from "award of prime contract" to "commercial operation date".



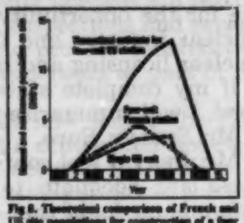


Fig 8. Theoretical comparison of French and US site populations for construction of a four-unit station, manual and non-manual population on site (assumes the same spacing for US units as for French units). There are no four-unit projects in the United States to provide a direct comparison with French four-unit stations.
Source: Refs 2, 4.

Need for regulatory reform. The performance of the better US LWR projects and the French experience indicate that significant reductions can be achieved in the capital cost of US nuclear plants. This can be done if the current US regulatory structure is changed by legislation to encourage stability during construction and to facilitate design standardization for a series of plants to be built over a number of years.

Grandfathering the project requirements to the date of the construction permit would facilitate a more orderly execution of the project. Grandfathering a design for a series of plants to be built over a number of years would encourage the transfer of learning between projects and other standardization benefits.

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3. J. H. Crowley, *US power plant construction cost experience*. Prepared for the French seminar, "Nuclear programme put into action, first international comparison, France-United States," University of Paris-Dauphine, 14 February 1985.
4. R. Carle and C. Pierre Zaleski, *Achievements of the French nuclear power programme*, presented to the International Scientific Forum, Fort Lauderdale, Florida, United States, 28-30 November 1984.

STATEMENT OF A. PHILIP BRAY

Mr. BRAY. Thank you. My name is A. Philip Bray, and I would like to thank the chairman and other members of the subcommittee for the opportunity to appear today to discuss the state of the nuclear industry and the proposals before Congress to reform the nuclear licensing and regulatory process.

If my complete statement can be accepted for the record as if read, I will summarize the statement now.

Mr. SHELBY. Sure.

Mr. BRAY. I feel confident that the proposals now before the Congress are adequate to assist in revitalizing the nuclear option. There is no doubt that a revised set of guiding principles is needed. Administration reform has been inadequate.

There are a number of problems affecting the nuclear industry today, including significant instability in the Federal and State regulatory and licensing process, decline in demand growth and uncertain demand projections, difficulties in continuing to raise capital to complete construction which results in the construction delays, lack of confidence that State utility commissions will allow appropriate cost recovery in the rate base, and construction management difficulties due to the continuous design changes.

It is worth noting that the nuclear technology is not at fault. Nuclear electric systems developed in the United States are being used all over the world safely and at reasonable costs. The French have proved that the U.S. technology nuclear units can be built safely and in almost half the time it takes in the United States.

For instance, construction began on the French Paluel Unit II in March 1978 and the unit was connected to the grid in September 1984. This is about 30 percent improvement over Lucie 2, which is the best record of recent construction duration here in the United States. What's going on?

The nuclear capacity in France in 1995 is expected to be 75 percent of total capacity, a tremendously successful program for U.S. technology.

I feel that the proposals currently before Congress from the commission, the administration, as well as the House and Senate would do a great deal to remove the terrible disincentives to use the nuclear power option by electric utilities. Four major areas of licensing reform are addressed in the NRC and DOE bills. Single stage combined construction permit and operating license called the COL; early site approval; approval of standardized designs; and licensing stability.

On early approval of standardized designs, the NRC would be authorized to approve standard designs for entire plants, giving utilities the option of choosing a basic plant of preapproved design. There is no question in my mind that if this option is not available U.S. utilities will not order any more nuclear units. Nuclear power will be used only by Japan, Russia, France, Italy, and others that understand the requirement.

Early site approval. The NRC would be authorized to approve sites for prospective nuclear plants in advance of the utility's decision to apply for a nuclear project. And that would be excellent and consistent with the standardized plant approach.

Combined construction permit and operating license. Utilities would be permitted to apply to the NRC for construction and operating license in one proceeding, as opposed to the current process whereby the construction permit and operating licenses are not obtained at different stages years apart. Tests, inspections and acceptance criteria and other matters necessary to provide construction quality assurance confirmation could be incorporated as part of the license.

Design modifications. Under the proposals now before the Congress the NRC would be required to conduct a centralized review of all staff backfitting proposals. In reaching a decision the NRC must be assured that the modification will substantially improve the protection of the public health and safety over the remaining operating life of the plant.

This concept is critical to the successful use of standardized plants. We must separate design review and certification from construction verification and site auditing. These are all excellent reforms and I urge you to adopt them.

I would also like to take this opportunity to propose an additional suggestion or interpretation for your consideration, and one that is totally consistent with the bills before you. My suggestion rests on the very appropriate analogy between nuclear and aviation industries.

Both of those industries are on the threshold of technology. Both industries have a high public safety awareness. Both have few overall system suppliers, but hundreds of subtier suppliers. Both industries have critical safety requirements and extensive quality control requirements. And uniquely, completed systems, planes, and plants are turned over to operating companies, airlines, and utilities.

In this view the current unacceptable NRC approach is like the FAA daring to question American Airlines about the proper angle of attack of a wing on its latest DC-10 when there are hundreds of DC-10's flying in the air. It is ridiculous.

The Congress, in my view, acted intelligently, responsibly, and prudently when it passed the legislation that established the FAA licensing process. Why don't you do it again and do your part in endorsing a prudent acceptance of nuclear power here in the United States in a very similar industry?

As you know, under theFAA system, an aircraft vendor—a McDonnell Douglas, a Boeing, whoever it might be—must obtain a frame certificate under the air worthiness system process for the design of each model of aircraft before it is sold. I can see much merit in the use of a similar approach for nuclear plants.

A Power Worthiness Certificate system, if you carry the analogy that far, would be a stimulant to competition as well. Just as Boeing, McDonnell Douglas, or even European Air bus seek early certification of new aircraft designs to get the edge on competition, so it could be in the nuclear industry. Utilities looking to buy a new nuclear plant could review the available certified designs, knowing that the designs are acceptable and are not further questioned about their design basis.

In closing, let me again say that I applaud your efforts in this matter and I urge you to recommend adoption of either of the proposals before you. Electrical load in this country continues to grow, even though not as rapidly as we have seen in the past.

The time is fast approaching when utilities will need to build additional power generating units. And unless some stability is brought to the regulatory environment for nuclear power our utilities will continue to ignore nuclear power for new additions and turn to other sources, principally coal and oil and even Canadian electricity.

The long term problems of those sources in terms of pollution, acid rain and foreign dependence are ones we cannot afford. Preservation of the nuclear option is in the best interest of all our citizens.

Thank you.

Mr. SHELBY. Thank you for your statement.

[Statement of Mr. Bray follows:]

STATEMENT OF A. PHILIP BRAY
BEFORE THE ENERGY, CONSERVATION AND POWER SUBCOMMITTEE
HOUSE ENERGY AND COMMERCE COMMITTEE
JULY 25, 1985

My name is A. Philip Bray. I am a Senior Vice President of Management Analysis Company (MAC). I would like to thank the Chairman and the other members of this committee for the opportunity to appear today to discuss the state of the nuclear industry and the proposals before Congress to reform the nuclear licensing and regulatory process.

Management Analysis Company provides consulting and management services primarily to the energy and utility industries. We have provided expertise and experience to assist in construction and operation of most of the nuclear power plant facilities in the United States. My principal responsibility is the management of MAC's Commercial Group which includes our international and domestic divisions as well as marketing and business planning. My experience includes all aspects of power plant design, testing, licensing, plant start-up and general management in the domestic and international nuclear power industries. I spent all of my professional career until recently with General Electric attempting to provide the United States with a successful nuclear power program for its utilities. My last assignment prior to early retirement in my 30th year of employment was Vice President and General Manager of GE's Nuclear Power System Division. I'm pleased that the U.S. nuclear program is the largest in the world, but I'm disappointed that its future is in jeopardy due to inappropriate regulation.

I have often been involved in Congressional hearings related to nuclear issues. I feel confident that the proposals now before the Congress are at least adequate to assist in revitalizing the nuclear option. There is no doubt that a revised set of guiding principles is needed, which legislation would enable, as administrative reform has been inadequate. I appreciate your holding hearings on these issues and look forward to a quick resolution of the differences and the reporting of a nuclear standardization and licensing bill.

There are a number of problems affecting the nuclear utility industry, including significant instability in the Federal and State regulatory and licensing process, decline in demand growth and uncertain demand projections, difficulties in continuing to raise capital to complete construction, resulting construction delays, lack of confidence that state utility commissions will allow appropriate cost recovery in rate base, construction management difficulties due to continuous design changes, and limited public acceptance of nuclear energy. The electric utilities have taken some very positive steps to improve operating plant performance through the INPO and NUMARC initiatives, but many of the critical issues cannot be solved by the nuclear industry. We need your understanding of the critical problem facing the nuclear industry - a problem that we have only in the U.S.

The current climate in the nuclear industry in the U.S. is such that there cannot be any future orders for nuclear units yet. Future orders are essential if the United States is to have an adequate source of domestic-supplied energy at reasonable cost. Even modest demand projections call for shortages in the mid to late 1990s, and I do not believe the country can afford inaction on maintaining the nuclear option. The U.S. has about lost the nuclear option.

It is worth noting that the nuclear technology is not at fault. Nuclear electric systems developed in the U.S. are being used all over the world safely and at reasonable cost. The French have proved that U.S. technology nuclear units can be built safely and in almost half the time it takes in the United States. For instance, construction began on their Paluel Unit II in March of 1978 and the unit was connected to the grid in September of 1984. This is about a 30 percent improvement over Lucie 2, which has the best record for recent construction duration here in the U.S. The nuclear capacity in France in 1995 is expected to be 75 percent of total capacity, a tremendously successful program for U.S. technology. Germany will be 25 percent nuclear by 1995; Taiwan is already over 50 percent nuclear both employ U.S. technology.

In the remarks that follow, I have chosen instead to focus only on those problems which I believe require legislative remedy - the problems with U.S. nuclear power regulation. Furthermore, I believe that once the regulatory uncertainty and instability are removed, many of the financing crises will just disappear.

Let me begin by briefly reviewing the problems I see with our regulatory approach. Instability in regulatory requirements, explosive growth in the number of regulations, and substantial backfitting requirements have all ballooned plant construction costs in this country. The regulatory process during the 1970s and 1980s was extremely unpredictable. Many utilities were forced to alter their schedules considerably in order to continue to raise money while trying to incorporate design changes and perform rework required to meet the ever changing safety criteria of nuclear regulation and the ever growing numbers of regulations. According to the U.S. Department of Energy,

> . . .the new regulations had large impacts on cost, especially when they required the removal and replacement of existing construction and the addition of structures and equipment to areas not designed to accommodate them. The new regulations were mainly responsible for large increases in the quantity of materials and manpower required for nuclear units (U.S. DOE, The Future of Electric Power in America, p. 310).

This regulatory instability also lengthened construction schedules and this in turn contributed to cost increases: ". . .protracted and complex licensing procedures, greater political opposition, and additional regulatory measures increase the capital costs of a given nuclear plant by postponing the flow of revenue from operation further into the future and by increasing total interest payments on construction loans. In short, delays cost money, and the costs are passed onto consumers in the form of more expensive electricity" (Steven Del Sesto, "The Rise and Fall of Nuclear Power in the United States and the Limits of Regulation", Technology and Society, Vol. 4, p. 310). A quick review of the data for 42 French units regarding estimated date of start-up announced at the time the reactors were ordered, reveals that there were only 2 cases of a delay of 3 years, 11 cases of a 2 year delay, 21 cases of a 1 year delay and 8 units which were delayed only a few months. ("World List of Nuclear Power Plants", Nuclear News, February 1985). Contrast this with the U.S., where delays of 8 to 11 years have occurred.

The following brief review of the history of regulation of the U.S. nuclear industry illustrates the instability and unpredictability utilities faced in attempting to build and license nuclear plants. Commercial nuclear power began as a government-controlled and government financed program in the U.S. By the late 1950s, it was transferred to the private sector. The government retained its charter, however, to promote nuclear power and regulate its safety through the AEC. Up until the early 1970s, the impact of regulatory control by the AEC upon plant schedules was minimal. Increases in the size and number of reactors being ordered by utilities in the late 1960s and early 1970s soon overwhelmed the capacity of the AEC's regulatory organization.

The Calvert Cliffs court decision in July 1971 declared that the AEC was required to satisfy the provisions of the National Environmental Protection Act (NEPA). Rather than limiting its reviews to safety-related issues, the AEC became responsible for a review of the broad range of environmental issues involved with licensing nuclear power plants. All licensees receiving a construction permit after January 1970 were required to submit an Environmental Impact Statement (EIS).

Review of construction permit applications was suspended in 1972 to allow the AEC to reorganize itself and its procedures to meet the NEPA requirements. As a consequence, some utilities had to wait to receive their construction permit while a EIS was prepared. Others were faced with more regulations then they would have faced if there had not been the licensing hiatus. More important, however, was the new requirement which did not allow utilities to begin construction of a plant until they had received a construction permit. The Calvert Cliffs decision may have added approximately 20 months to the construction lead-time and, hence, the cost of the nuclear power plants awaiting issuance of a construction permit (Electric Power Research Institute, Analysis of Power Plant Construction Lead Times).

In 1975, the AEC was disbanded and the NRC established in its place, but this did not restore stability. No construction permits or operating licenses were issued for approximately one year while the new NRC sorted out its role and responsibility. The NRC continued to revise, re-interpret and reapply the criteria outlined in the regulatory guides. Figures 2 and 3 portray the increase in the numbers of NRC regulations and requirements.

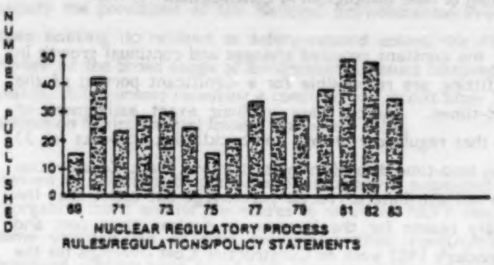
The AEC and its successor, the NRC, continued to develop nuclear safety requirements throughout the early 1970s which added to the required safety detail of reactors being built at that time. The fire at Browns Ferry in 1975, however, compounded the amount of safety detail required to a great measure. Following the fire, a whole new set of fire protection, safety and inspection practices and cable layout regulations were established. Both plants beginning construction and those well into construction at this time were required to make extensive design changes in order to comply with these new regulations.

The accident at Three Mile Island Unit 2 in March 1979 also increased the number of new regulations issued as well as the number of regulations reviewed. The year-long moratorium on licensing resulting from TMI had a significant impact on the lead-time and cost of plants ready to load fuel or near completion of construction.

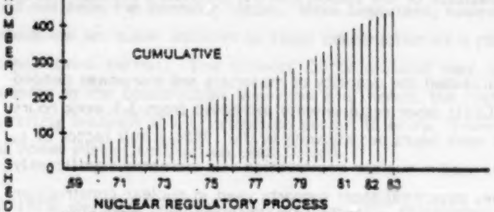
The design changes inflicted by the constant required changes and continual growth in regulation and mandatory backfitting are responsible for a significant portion of the increasing of construction lead-times. Sources vary in their exact assignment of responsibility. EPRI concluded that regulatory change and backfitting accounts for 53 percent of the total construction lead-time delay (Analysis of Power Plant Construction Lead Times). Other sources do not attribute a precise percentage but claim that the regulatory process was a primary reason for the increase in nuclear plant cost and schedules. (See for example Canaday's 1982 work on Construction Cost Overruns for the National Regulatory Research Institute or the Edison Electric Institute's Nuclear Power Task Force Report.)

These new regulations greatly increased the quantity of materials and manpower needed to build large nuclear plants. Craft labor requirements increased from 3.5 work hours per kilowatt in 1970s to over 21 work hours per kilowatt in the 1980s, a full factor of 6. In addition, the cost of materials used in nuclear construction was increased significantly by new regulation. For example, structural steel supports used in nuclear construction today cost up to three times as much as the same quality supports used in general construction in our county (U.S. Office of Technology Assessment, Nuclear Power in an Age of Uncertainty). These documented cost increases did not occur as sharply in other nations using U.S. technology.

GROWTH OF NUCLEAR POWER PLANT REGULATORY REQUIREMENTS: RULES, REGULATIONS AND POLICY STATEMENTS*

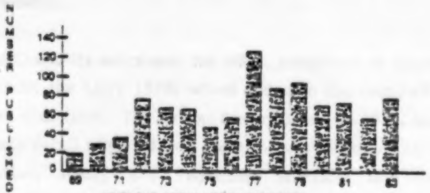


NUCLEAR REGULATORY PROCESS
RULES/REGULATIONS/POLICY STATEMENTS



NUCLEAR REGULATORY PROCESS
RULES/REGULATIONS/POLICY STATEMENTS

GROWTH OF NUCLEAR POWER PLANT REGULATORY REQUIREMENTS: WASH/NUREG DOCUMENTS**



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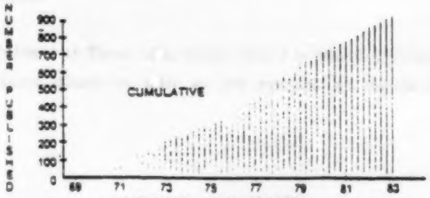
WASH & NUREG DOCUMENTS



NUCLEAR REGULATORY PROCESS
WASH & NUREG DOCUMENTS

To sum up, then, the regulatory review process has resulted in hundreds of differentiating design changes. In many cases I believe that these NRC-mandated changes have not resulted in any improvement to the public health and safety. Even if the intended design is identical to an approved, licensed project, each new application receives a total safety review. In a related example, an electric utility currently involved in completing a nuclear unit will undergo at least 8 more separate NRC audits in the next several months prior to fuel load. Each one of these audits will consider not only the adequacy of the construction but the appropriateness of the design. Thus, at this late date, when the attention of the project management and site personnel should be focused exclusively on finishing up remaining work and systems turnover, they are devoting the bulk of their energy to preparing to continue to defend the design of the plant to the auditors. The current regulate-and-design-as-you-go process is not serving the needs of the electric utilities. They will not order new plants which will be needed in the future.

I feel that either of the proposals currently before Congress from the Commission and the Administration would do a great deal to rectify these problems in the regulatory process and remove the terrible disincentives to the use of nuclear power by electric utilities. Utility executives are not willing to commit to the construction of a nuclear plant and run the risk of it not being licensed. Four major areas of licensing reform are addressed in the NRC and DOE bills: Single-stage combined construction permit/operating licensing (COL), early site approval, approval of standardized designs, and licensing stability.

o Early Approval of Standardized Designs

The NRC would be authorized to approve standard designs for entire plants giving utilities the option of choosing a basic plant of pre-approved design in lieu of a one-of-a-kind or customized plant design. There is no question in my mind that if this option is not available, U.S. utilities will not order any more nuclear units - nuclear power will be used only by Japan, Russia, France, Italy and others that understand its requirements.

- **Early Site Approval**

  The NRC would be authorized to approve sites for prospective nuclear plants in advance of a utility's decision to apply for a nuclear project. That would be excellent and consistent with the standardized plant approach.

- **Combined Construction Permit and Operating License**

  Utilities would be permitted to apply to the NRC for a construction and operating license in one proceeding, as opposed to the current process whereby the construction permit and operating licenses are now obtained at different stages. Tests, inspections, acceptance criteria, and other matters necessary to provide construction quality assurance would be incorporated as part of the license. NRC inspectors would be permitted to approve major systems or tests as they are completed to avoid reopening old issues at the end of construction. Let me just note that in my view the ideal process would be similar to the one used in Japan. A company first receives an Establishment Permit that approves the siting and design and authorizes them in one step to build the plant, to load the fuel and to go to power. This is followed by a Certification Inspection once construction is complete to verify that everything was built as the Establishment Permit required.

- **Design Modifications**

  The process by which the NRC has imposed modifications to designs during and after plant construction has certainly lacked discipline. Numerous means for making changes have been employed; technical problems and their solutions are examined narrowly and without top management review, often without adequate consideration for how an isolated, specific modification may affect overall safety performance.

  Under the proposals now before the Congress, the NRC would be required to conduct a centralized review of all staff backfitting proposals. Such a review would result in a more disciplined process for approving backfits--a process based on a quantitative assessment of the seriousness of the underlying safety concern, the value of the safety improvements that would result, and the cost of making the modification. In reaching a decision, the NRC must be assured that the modification will substantially improve the protection of public health and safety over the remaining operating life of the plant. This concept is critical to the successful use of standardized plants. We must separate design review and certification from construction verification and site auditing. I would like to suggest that the backfitting criteria for plants under construction be no different than for operating plants. If a problem is perceived by the NRC to be serious enough to warrant shutting down operating plants, then there is sufficient basis for changing the certified design.

These are all excellent reforms, and I urge you to adopt them. I would also like to take this opportunity to propose an additional suggestion for your consideration. My suggestion rests on the very appropriate analogy between the nuclear and aviation industries. Both industries are on the threshold of technology. Both industries have a high public safety awareness, few overall systems suppliers but hundreds of sub-tier suppliers. Both industries have critical safety requirements and extensive quality control and quality assurance requirements. Completed systems (plants or planes) are turned over to operating companies (utilities or airlines).

In this view, the current unacceptable NRC approach is like the FAA questioning American Airlines on the proper angle of attack on the wing of the DC-10 when there are already over 200 DC-10s in the air.

The Congress in my view acted intelligently, responsibly and prudently when it passed the legislation that established the FAA licensing process. I would urge you to consider a similar approach for nuclear power. For many years I personally have advocated, as has G.E., the concept of Power Worthiness Certificates. Congress was effective in passing a similar law for the FAA - why not do it again and do your part in endorsing a prudent acceptance of nuclear power here in the U.S.?

As you know, under the FAA system, an aircraft vendor (McDonald-Douglas, Boeing, etc.) must obtain a frame certificate (the air worthiness system) for the design of each model of aircraft before it can be sold. I can see much merit in the use of a similar approach for nuclear plants. System suppliers, rather than utilities, would be responsible for securing an NRC Power Worthiness Certificate for standardized plant designs. Each system supplier could seek approval of more than one design if it wished to do so - just as Boeing does. The utility and its constructor would then build the plant with high-level guidance from the system supplier. Upon completion, the plant's construction would be certified by the NRC to be in accordance with the requirement of the power worthiness certificate.

Use of a Power Worthiness Certificate system would constitute a federal endorsement of this disciplined acceptance of nuclear power. Public acceptance would certainly improve. Orderliness could return to the licensing process. For nuclear construction projects employing a certified design - a design with a Power Worthiness Certificate - it would not be incumbent on the NRC to raise hundreds of design questions.

A Power Worthiness Certificate system would be a stimulant to competition as well. Just as Boeing, McDonald Douglas and even the European Air Bus seek early certification of new air craft designs to get the edge on competition, so it could be in the nuclear industry. Utilities looking to buy a new nuclear plant, could review the available certified designs knowing that the designs are acceptable. I further believe that there is no question of restricting utilities to buying certified designs only. In the absence of prior approved designs, they now feel that they cannot risk the financial exposure of building a new plant. If we adopt a system in which certified designs that are not subject to continuously changing regulations are available, all utilities will use certified designs.

On the subject of the fractions of the nuclear plant design that can be preapproved or certified from a safety point of view, I am confident that all of the safety data required by the NRC to sign off the plant design can be provided with due consideration of restraint of trade possibilities. At GE we modeled this as the air frame manufactures do. For instance, the safety data would specify a required pump characteristic for use in a safety analysis. The analysis would be accepted. Later on for a given project; any vendor whose pump satisfied the required pump characteristic could provide it. I'm confident that such a system can work for the nuclear industry. I look forward to the opportunity to continue to pursue this objective.

In closing, let me again say that I applaud your efforts in this matter and I urge you to recommend adoption of either of the proposals now before you. Electrical load in this county continues to grow even though not as rapidly as we have seen in the past. The time is fast approaching when utilities will need to build additional power generating units. Unless some stability is brought to the regulatory environment for nuclear power, our utilities will continue to ignore nuclear power and turn to other energy sources, principally coal and oil or even Canadian electricity. The long-term problems with those sources, in terms of pollution, acid rain, and foreign dependence, are ones we cannot afford. Preservation of the nuclear option is in the best interests of all our citizens.

I am confident that a disciplined regulatory process is the key to restoring viability to the nuclear option.

Mr. **Wolfe**. Mr. Shelby, I have a plane to catch and I would be happy to answer any specific questions now or, if I could otherwise be excused, Mr. Glen Sherwood who is in charge of GE's licensing would take my place.

Mr. **Shelby**. We have had the benefit of your testimony, and if we have any questions and wanted to write you or the staff, would that be sufficient?

Mr. **Wolfe**. I would be delighted.

Mr. **Shelby**. Thank you, you go ahead and get that plane.

Mr. **Wolfe**. Thank you very much.

Mr. **Shelby**. First of all, the chair wants to introduce into the record his opening statement. I was not here then. Of course, we are meeting in the full committee and without objection this will be made part of the record.

I have several questions. You were talking about—I believe it was Mr. Bray—how much of a design can be standardized?

I know the French are doing that. Last summer I had the opportunity, when Congressman Waxman and I were in Paris, to meet with some of the energy people regarding the standardization of their nuclear capability. And that has come a long way as far as—I think you used the figure 75 percent of their energy needs are going to come from nuclear as soon as the plants, all of them come online; is that correct?

Mr. **Bray**. That is correct.

Mr. **Shelby**. And they are using a standard format as far as the plants that they are building, isn't that right? 5

Mr. **Bray**. That is right.

Mr. **Shelby**. How much of a design in the United States could be standardized? I assume if it can be done there it can be done here.

Mr. **Bray**. Certainly.

Mr. **Shelby**. And how much of the balance of the plant could be included in the design? In your statement you were talking about drawing an analogy to airplanes and the FAA and they have to be airworthy to get their certificate to fly. How would that work here?

Mr. **Bray**. Well, first of all you differentiate between the amount of detail design information that the field needs to construct the plant. And you would differentiate that from the amount of safety analysis that the commission needs to come to the conclusion that if the plant were built it could be safe with no undue risk to the health and welfare of the public.

And that we feel, all of that data c ould be supplied early so the standard plant could be approved. Of course, it might be subject to various tests or analyses from the as-built condition to verify that the builders did it the way the certificate called for it to be done.

Mr. **Shelby**. Sure. What would be lost by the standardization? There is always a downside.

Mr. **Bray**. Well, relative to what we have without it, it all looks brighter to me.

Mr. **Moore**. Mr. Shelby, perhaps I could build on that.

Mr. **Shelby**. Go ahead, Mr. Moore.

Mr. **Moore**. I think what can be lost—the French have a little different situation. They have one utility for the whole country and——

Mr. **Shelby**. They have got a monopoly on the whole deal, the whole licensing process.

Mr. **Moore**. Right, and one supplier, and that is surely not what we are advocating in the United States. I think the potential downside and what we have to be careful about is, as Mr. Bray pointed out, one can standardize the licensing criteria, the systems and so forth up to the point where you can specify buying particular hardware.

But you want to maintain the competitiveness of the industries in the United States, and that is one issue you have to concern yourself with. And the other is a mechanism to bring in on a rational basis, new technology as it is developed. Results of new R&D—research and development—new microelectronics, what have you.

So you have got—in your standardization process, have to have a mechanism to bring that in in an evolutionary way.

Mr. **Shelby**. I am not a nuclear physicist but we have sat through—I know this is my fourth term on this committee and I know there are differences between the design of a Westinghouse unit and a GE unit or a combustion engineering, but is it that much different?

Mr. **Moore**. Not really when you set the basic safety criteria. The specific functions of the systems may vary one to another, but when you take the basic ground rules and safety criteria, they in essence meet the same requirements.

Mr. **Shelby**. Are they all light water reactors?

Mr. **Bray**. Yes. And principally what you want to keep in mind is what we have in the aircraft industry. How similar is a 747 and a DC–10.

Mr. **Shelby**. Or the Tri-Star.

Mr. **Bray**. Or whatever. They supply to the FAA a docket of data sufficient for the FAA to conclude that when it is built and meets certain tests prior to commercial operation, it will be deemed safe.

Mr. **Shelby**. They build around those parameters.

Mr. **Bray**. That is right. And a similar principle could be employed here. One thing that has grown in our industry, for instance, is to constantly review, constantly change design. But when we get the pump from a particular manufacture, supply that pump curve to the commission so they can say it is safe.

What you have to get on to is a system in which the supplier or the designer supplies a curve of a required characteristic, which if it were there the plant's analysis shows it is safe. And then use that required curve so that many vendors or pump suppliers could bid competitively.

Mr. **Shelby**. Let's talk about these steps now in the perspective of safety, which we are all interested in, because that is one thing that has slowed down in this country. People's perception, are they safe.

How can we make sure that they are more safe and so fort h? Would a standardized criteria that you are advocating, would not that help insure that those safety features are there?

Mr. **Bray**. Absolutely.

Mr. **Shelby**. I am speaking in the design, not the operation. I know that many things happen there, lack of training and so forth.

Mr. **Bray**. Yes, I think so. In fact——

Mr. **Shelby**. Cut the risk factor, would it not?

Mr. **Bray**. It would be attractive. In fact, I could even see press attention not to some admonition against the utility, but imagine the favorable press the day the commission concludes that a particular vendor's design was certified. Just like the headlines you saw the day the 767 was certified. It could be an upbeat type of statement about the industry.

So I think it would enhance confidence in the public.

Mr. **Shelby**. What would it do to competition? Could it curtail competition, imagination, or is it just——

Mr. **Bray**. No, as you will see in my complete statement on the record, I see an opportunity to be very parallel to the aircraft industry again where competition is stimulated.

Each of them can go to the NRC in that type of a process with their own application, attempting to have a more complete application, more safety data up front, so they can get an early certification and go out into the marketplace claiming to the utilities that their plant is totally signed off and ready to be built, fuel loaded, and taken to power.

Mr. **Shelby**. If you did have these standardized designs that we adopted and so forth, could that not cut out a lot of the problems on the construction slowness here and there? And also, what about the permit process?

Mr. **Bray**. Yes, again in my complete statement there is an example of a site I was at recently where instead of looking at whether they are building the way the permit called for it, they have between now and 6 months from now when they plan to load fuel, nine independent design reviews by the commission at the site.

So I know those people are preoccupied with preparing to defend a design philosophy, rather than getting the site ready and clean to go to power. So I think standardization there with a prior signoff that the design is acceptable, and now the question is, are you building it the way you said you would. And if it was confined to that you would have a much healthier industry.

Mr. **Shelby**. Would standardized designs for nuclear powerplants, would that alter the basic, or the historic relationship between nuclear vendors and architect engineers, and so forth? Would you like to address that, Mr. Crowley?

Mr. **Crowley**. Yes, I think in retrospect the industry has talked about standardization in my memory for 8 years and manufacturers and others have appeared to make a step in that direction.

For some reason in this country we have not standardized. Every plant with a few exceptions is a first of a kind with the utility having its unique requirements, and the A&E having its unique requirements. In their responding to new regulatory criteria, the evolution of their interpretation is sort of a new exercise.

So I agree it—standardization—is highly desirable, but using Phil's airplane analogy, our current practice is that if we have a DC-10 designed to land at O'Hare in Chicago, it could not be licensed to land in Denver. That is, it is site specific.

So our current standardization approach needs, I think, some discipline in how we interpret our regulations, much like the French do. Now their standardized designs are standardized to the point—

and I verified this in Paris about 3 months ago—that they have standardized drawings and they qualify them for multiple sites. It is not just dedicated to one site.

In this country, any attempt at standardization would probably require substantial redesign to adapt it to alternate sites. Another point—I am not trying to introduce negatives but to get standardization, I think we have to be aware of these—is that our requirements are that you have to go competitively for pumps, equipment, heat exchangers, etcetera. There is also a Securities and Exchange law that prohibits utilities from buying exactly the same hardware. And if you do not comply, you do not have standardization within the framework of the regulatory criteria as we know it.

Mr. **Shelby**. Mr. Moore, you have some comment?

Mr. **Moore**. To add to Mr. Crowley's comment, that is why we say, you can get standardized designs up to the point of the specific hardware and still meet essentially of the benefits and requirements of standardization. The relationship between the vendor, the architect engineer, and the utility does not have to change in the sense of who is actually doing which work.

But what is going to change, I believe, in this concept is there will be a single point responsibility for the regulatory aspects, the safety aspects of the design. And that is what will go through the standardized design process. So we will get some control over that.

And that could be Westinghouse, that could be utility, could be an architect engineer, but there will be a single point of responsibility. And that relationship is different now, because that responsibility varies and there are a lot of interfaces in the current situation.

I would like to make another point on the French. The French have at least, to my knowledge, now four standard designs. What they do is they will design and license a series of plants, be it 8, 10, 12 plants. They will build those plants all alike, while they are working on the next generation of design for their next standard.

So it is a very disciplined process. And the key is, when they start up front and they approve that one design, it is approved for many sites and that one design across the board. And that is why——

Mr. **Shelby**. Saves a lot of money too, does it not?

Mr. **Moore**. Absolutely, and that is why it is important that we talk here about standardizing the design, but also a combined construction permit, operating license licensing process.

Mr. **Shelby**. Are you familiar with what the Chinese are trying to do?

Mr. **Moore**. Yes.

Mr. **Shelby**. I know several of us on the committee, including Chairman Dingell met with the members of the People's Republic of China a couple of years ago. And it is all in the news now because of what the President has done recently as far as agreeing to sell nuclear technology for power plants.

And they were telling us in all the meetings, you know, they were wanting the American designs.

Mr. **Moore**. That is right. Our technology——

Mr. **Shelby**. Because our technology was—they thought was the best, the newest, with all the innovations or whatever, the new generation, as opposed to the French, the Japanese, and the Germans, too.

Mr. **Moore**. That is right. That is our understanding. They want the current technology. And the discipline we as an industry have to have is we have got to say this is the design for the next *x* plants and the next *x* years and stick to it. We have not done that as an industry. And that is an obligation on the part of the Congress, and an obligation on the part of the NRC and ourselves.

Mr. **Shelby**. What about the Japanese, are they using standardized designs with American equipment and so forth and so on?

Mr. **Moore**. Very much so. The Japanese designs are based essentially on U.S. technology, General Electric's and Westinghouse. And they design and build standard plants, again licensed up front. They build them in 4 to 4½ years and get excellent performance.

Mr. **Shelby**. What about the Soviet Union, do you have any knowledge there?

Mr. **Moore**. Very vaguely. They also have a standardized design approach.

Mr. **Crowley**. I might be able to speak to that.

Mr. **Shelby**. Sure, go ahead.

Mr. **Crowley**. Having been involved with the International Atomic Energy Agency in Vienna, I have had interactions where the Eastern bloc countries have talked about the Soviet design, which is currently a 440-megawatt, two-loop pressurized water reactor. That is the one that has been built very broadly all over Eastern Europe. I understand one of these is being built in Cuba.

Mr. **Shelby**. What is that comparable to, some older models?

Mr. **Crowley**. It would be an older model of an early era—well, I guess a Westinghouse plant.

Mr. **Moore**. Yes, about that size.

Mr. **Crowley**. As a point of interest though, a lot of those earlier plants do not have containment as we do. They have a concrete house around it so they do not have the protection at those units that we do. And I understand recently they have changed that.

But again, their schedule and cost performance is incredibly good. They are now, I guess, committing to the larger pressurized water type of plants.

Mr. **Moore**. They apparently do not have a licensing problem.

Mr. **Shelby**. No, they do not have any. [Laughter.]

Let me ask you this, do the French prototype the first of a series, is that what they do?

Mr. **Moore**. Well, they basically will come up with—for example, they standardized initially on the three-loop plant. That is a plant of about 900 megawatts electric. And they built a series of those.

Then they went to a four-loop plant design, a higher rated plant. They built a series of those. Now they are on another series of four-loop or even higher rated plants, and these are in design sets. So they will run, as I said, like 10 or 12 plants in one set of designs will all be the same. Then the next set will be the new generation.

Mr. **Shelby**. As far as nuclear powerplants are concerned at the present time, currently in other words, does the U.S. capability have the most improved safety features and so forth? Would that be a loaded question?

Mr. **Crowley**. Maybe we can each take a turn at answering the question. In a way the trust of safety was disturbed somewhat by Three Mile Island. But be that as it may—I do not want to give away my age—but after 30 years in the nuclear business, I do not know anybody who has ever been hurt or killed as a consequence of a nuclear plant operating.

Although we are now spending 10 times more for these plants today than we did in the past, those plants built in the past which we spent a factor of 10 less for, have had a wonderful, marvelous operating experience.

So I think we are spending money and we are not getting the derived value for the money we are spending.

Mr. **Bray**. I think that is true.

Mr. **Moore**. I would add, I think, that there is kind of a dichotomy here that we are involved in a joint program with the Japanese working on an advanced PWR, which takes the latest design considerations building on a lot of operating experience in coming up with a more inherently safe, more efficient powerplant. We are doing that with the Japanese because we do not have the basic support and market in the United States to support that.

Mr. **Shelby**. You mention the French are coming online with tremendous nuclear capability and we are familiar with that, to generate about 75 percent of their energy needs in the next 3 or 4 years, whenever their plants are finished. What about the Japanese? How much energy are they planning to get from their nuclear?

Mr. **Moore**. I think it is approaching—they have an aggressive program going on now, and I think they are driving at something like 40 percent or so. I think that is where they are trying to get to, somewhere between 40 and 50 percent.

Mr. **Shelby**. The higher they go though, that will really enhance their industrial base without oil and gas.

Mr. **Moore**. Absolutely. It is again a question of their indigenous resources and their economic power.

Mr. **Bray**. Of course, Japan is different than the United States in that they do not have coal reserves and oil reserves and they are dependent for any form they use, it is going to be imported. But they find nuclear will give them a greater stability to their industrial base and so they are going for it. So they will be at twice our percentage in the next few years.

Mr. **Shelby**. Have they experienced a lot of cost overruns and so forth in Japan in the building and construction? Are their things within budget or what?

Mr. **Bray**. No, they have had cost overruns just due to inflation from the time equipment was purchased, from the time of the original cost estimate on the project. But not the runaway costs we have seen in the United States where changing designs all through the construction causes a utility to go back to its public utility commission and other places to raise more money, which requires more interest payments, which results in delays because they just cannot keep up with the money fast enough, which results in higher payments of interest, et cetera. Japan does not see that.

Mr. **Shelby**. Does the gentleman from Texas have any questions of the panel?

Mr. **Bryant**. No.

Mr. **Shelby**. OK, gentlemen, I want to thank you on behalf of the committee for appearing with us today and presenting your testimony and answering our questions. Thank you so much.

We are now ready to hear from the third panel. Mr. Cook is a journalist with Forbes magazine and published a very perceptive analysis of the nuclear industry last February. We will also hear from Mr. Gordon Corey, former vice chairman of Commonwealth Edison; Mr. John Sillin of Alexander Grant & Co.; and Mr. Mark Rowden, a former NRC commissioner and Washington attorney. Gentlemen, if you will come forward.

As all of you know, your written testimony will be submitted and made part of the record without objection. And if you would briefly sum up in 5 minutes or less any comments you want to make regarding your testimony, this will enable us to move on and hopefully ask you some questions and learn something from you.

Who wants to go first? Mr. Cook?

STATEMENTS OF JAMES COOK, EXECUTIVE EDITOR, FORBES MAGAZINE; GORDON COREY, FORMER VICE CHAIRMAN, COMMONWEALTH EDISON CO.; JOHN SILLIN, ALEXANDER GRANT & CO.; AND MARCUS A. ROWDEN, ESQ., FRIED, FRANK, HARRIS, SHRIVER & KAMPELMAN

STATEMENT OF JAMES COOK

Mr. **Cook**. Thank you, Mr. Chairman, for inviting me here.

Under current conditions it seems to me the nuclear option is dead. As the current program gradually winds down, costs have risen so high that many of the plants still under construction are no longer competitive with coal, their principal competition, and some are not even competitive with oil.

There is no doubt that the prospects of the nuclear power industry would have been considerably different if power demand had maintained its historical growth rate throughout the 1970's. Overall costs would almost certainly have been lower.

The demand was not sustained. The growth in demand fell off, and even declined. And so the urgency for completing plants under construction or in the planning stage abated noticeably. Inevitably, this resulted in increased cost, and then as construction resumed, set up plant after plant for the explosive inflation that beset the economy as the 1970's progressed.

If the United States had been threatened with electric power shortages as it seemed to be threatened with shortages of oil, the United States would have paid whatever price it needed to get electricity and would have considered itself lucky to have gotten it, and may do so yet if the electrical demand increases as rapidly as some experts have already begun to predict.

How do you apportion responsibility among the various forces that served to bring the nuclear power industry to its knees? I do not think that anyone honestly can answer that question. The responsibility, it seems to me, is interlinked and shared, with each of the forces feeding off and enforcing the deficiencies of the others.

But this much seems clear to me. The blame can be laid at the feet of not only the NRC and the antinuclear forces, but also the regulatory commissions and the industry itself—the utilities, the suppliers, the vendors, the architect engineers, the construction managers.

None of them had any great incentive to keep costs under control in the greatest inflation of construction and interest costs in American history. And far too few of them did.

These costs are far from over. The cost of maintaining the industry's existing nuclear plants is considerable, running to tens of millions of dollars per unit per year, and such costs continue to be compounded by the second thoughts of the safety oriented NRC—process that may accelerate in the years ahead as the NRC becomes more and more concerned with assuring the safety of the existing plants and the integrity of those yet to come.

And looming ahead are the problems of waste disposal and plant decontamination whose costs and problems have not yet been resolved.

I think the general concern about safety will slowly abate as these plants establish the safety record. But the industry had better be sure that they do build such a record. The accident at the Davis-Besse plant this spring is not exactly encouraging and the industry had better be sure that another accident like Three Mile Island does not occur.

Someday the considerable excess generating capacity the industry has built up will be exhausted and the United States will have to begin building powerplants again—large, central station powerplants, or so I believe. And nuclear power has been so successful almost everywhere else in the world, safe, low cost, efficient, that nuclear power ought to be at least an option the United States could exercise if it chose to.

To accomplish that much will probably have to change. Utility executives will have to be assured that they can bring new nuclear plants into operation at some reasonable cost and within reasonable time periods. They must also be assured that they can recover, again within a reasonable time period, the investments that they will have to make in order to build these plants.

To accomplish that a number of conflicts will have to be resolved, between State and Federal Government regulatory powers, between the special-interest groups, consumer and environmental groups, for instance, and the common good, between the corporate need for return on investment and the public need for low-cost power.

For legislation to resolve such conflicts is politically possibly, but seems unlikely to me. Certainly it is impossible to legislate good management either by Government or business. What might prove more effective is a reconstituted NRC or perhaps a parallel agency charged with finding ways and means of encouraging the development of nuclear power and resolving these basic conflicts.

Thank you.

Mr. Bryant. Thank you. Mr. Corey.

[Statement of Mr. Cook follows:]

SUMMARY OF STATEMENT BY JAMES COOK, EXECUTIVE EDITOR OF FORBES MAGAZINE, BEFORE THE HOUSE SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

Under current conditions, the nuclear energy option is dead. As the current program gradually winds down, costs have risen so high that many of the plants still under construction are no longer competitive with coal, their principal competition, and some are not even competitive with oil.

The blame can be laid at the feet of not only the NRC and the antinuclear opposition, but also the industry itself the utilities, the suppliers, vendors, architect/engineers, construction managers. None of them had any great incentive to keep costs under control in the greatest inflation of construction and interest costs in American history, and far too few of them did. These costs are far from over. Nuclear plant maintenance continues to be a costly procedure, and the industry has not yet coped with the eventual problems of waste disposal and plant decontamination.

Someday the considerable excess power generating capacity the industry has built up will be exhausted, and the U.S. will have to begin building power plants again, large central-station power plants. Nuclear power has been so successful almost everywhere else in the world safe, low-cost, efficient that nuclear power ought to be at least an option the U.S. could exercise if it chose.

To accomplish that, much will probably have to change. Utility executives will have to be assured that they can bring new nuclear plants into operation at some reasonable cost and within reasonable time periods. They must also be assured that they can recover, again within a reasonable time period, the investments that they will have to make in mounting these plants. To accomplish that a number of conflicts will have to be resolved between state and federal regulation, between consumer and environmental activists and government policy, between private and public interests. Whether legislation to resolve such conflicts is politically possible seems unlikely. What might prove more effective is a reconstituted Nuclear Regulatory Commission or perhaps a parallel agency charged with finding ways and means of encouraging the development of nuclear power.

STATEMENT BEFORE THE HOUSE SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

My name is James Cook. I am a journalist and an executive editor with Forbes magazine. I have been writing about business matters for nearly 30 years now, among them energy and the utility industry, and my views on the nuclear power industry are derived in large part from the research I undertook last year in connection with a lengthy article that appeared in our issue of February 11, 1985.

Under current conditions at least, hardly anyone maintains that the U.S. has a nuclear option any more. No U.S. utility executive is prepared to even consider building a new nuclear power plant. Or at least that's what most of them say. It's hard to be sure that they mean it, because because it's a choice that no one at this point needs to make. There isn't as yet any need for such power. At most, some utilities face the even more difficult decision of having to revoke a choice that's already been made and cancel a nuclear plant that's under construction.

For years, most of the blame for the failure of the U.S. nuclear power program went to the delays created by either the opposition of the antinuclear groups or the insatiable demands of the Nuclear Regulatory Commission. Together, they delayed the construction program, multiplied its costs, and created so much uncertainty that the program collapsed of its own weight. And there's no question that the NRC and the antinuclear groups were responsible for a large part of what happened.

But that, it seems to me, is only a part of the story. As critical a part is one the nuclear power industry has preferred not to face publicly_ its own role and that of the state regulatory commissions in the failure of the program. If you look at the cost levels projected for the three or four dozen nuclear plants that still had not gotten their commercial operating licenses at the beginning of last year, you'll find an extraordinary variation in results, running from under $1,000 per kilowatt of capacity to over $5,000. Depending on how you calculate it, that puts the average somewhere around $2,800 a kilowatt, and at $2,800 a kilowatt nuclear power is in general not competitive with coal, never mind that some plants still under construction are probably not going to be even competitive with oil.

There is, of course, tremendous variation in the circumstances under which the industry operates, different regulatory and environmental conditions, different labor laws and working conditions, differing social and political conditions, but it's hard to conclude that the differences are so great as to produce that $1,000 to $5,000 range of results that the industry actually has produced. Labor costs after all are not appreciably higher in Chicago than in New York, nuclear opposition less pronounced in California than on Long Island, or even NRC regulation more burdensome in Georgia than in Florida.

Which is why I argue that the failure of nuclear power is a management failure, and there is plenty of evidence to suggest that this is the case. There are enough examples of successful nuclear power projects both in the past and at present to make that abundantly clear, and the successes, it seems to me, make the case against the failures.

By management, of course, I do not simply mean utility management, though ultimately I suppose that is where much of the reponsibility lies. I also include the NRC and the local rate commissions who created the context within which the utilities operated, as well as the architect/engineers, the construction managers, the vendors, and the subcontractors to whom the utilities delegated responsibility for implementing their nuclear programs.

The heart of the matter is cost. Costs which outran the ability of management to finance them, regulators to countenance them, and consumers to pay for them. And these costs ran so badly out of control, it seems to me, because far too few of the groups involved had any inherent commitment to keeping them under control or, even if they did, to call a halt to them when it became clear that they had become uncontrollable.

As I see it, in fact, the failure of the U.S. nuclear program was made possible by the very people who ought to have wanted it most to succeed.

There was, first of all, the Nuclear Regulatory Commission, which not only did not consider the cost of the safety-related changes it dictated, especially after the Three Mile Island accident, but was not even supposed to consider them. And still isn't.

There were the contractors and subcontractors, the designers, the engineers and the construction managers who were protected by their cost-plus fixed-fee contracts and so had little incentive to question the cost-effectiveness of the NRC's dictates, and all too often did not.

Then there were the utility managements, who accepted the notion that no price was too high to pay for safety, and who believed in any case that no matter what happened to cost and construction schedules, the rate commissions would somehow provide the revenues to bail them out.

And finally, there were the state regulatory commissions, who not only failed to impose any check upon costs, but felt they had no obligation either to curb them or to provide the revenues needed to implement the scheme they had given their approval to. And still don't.

There's no doubt that the prospects of the nuclear power industry might have been considerably different if power demand had maintained its historical growth rate throughout the Seventies. Overall costs would almost certainly have been lower. But demand was not sustained. The growth in demand fell off and even declined, and so the urgency for completing plants under construction or in the planning stage abated noticeably, and this inevitably increased costs at least moderately, and then, as construction resumed, set up plant after plant for the explosive inflation that beset the economy as the Seventies progressed. If the U.S. had been threatened with electric power shortages, as it seemed to be threatened with shortages of oil, the U.S. would have paid whatever price it needed to to get electricity and would have considered itself lucky to have got it, and may do so yet if electrical demand increases as rapidly as some experts have already begun to predict.

How do you apportion responsibility among the various forces that served to bring the nuclear power industry to its knees? I don't think anyone can honestly answer the question. The responsibility, it seems to me, is interlinked and shared, with each of the forces feeding off and reinforcing the deficiencies of the others.

In any case, the nuclear program shapes up as the largest managerial failure in business history_$125 billion spent as of the beginning of last year, $140 billion to be spent by the end of the decade. That's more than the $200 billion we spent on the space program, or the $125 billion we spent in Vietnam. And it will not only not produce the low-cost power it was advertised to produce, it will have called into question not only the safety of the plants already in operation, but the nuclear technology itself. Of more immediate concern, it will change and is changing the economic geography of the U.S., and conceivably impairing even its international competitiveness.

Everyone has learned from bitter experience. The nuclear supply industry is beginning to disappear, getting out of the business, getting into something else. The utilities are abandoning their commitment to provide the country with power, committing themselves to preserving their financial integrity. The regulators seem bent on punishing the very companies whose properity and welfare should be a matter of overriding public interest, and doing so for actions that they themselves were parties to. More and more commissions refuse to provide the rate increases the utilities need to recover the investments they have made in their nuclear programs. It's not difficult to imagine a day when more nuclear power will be needed and the U. S. will no longer possess the necessary nuclear skills to provide it. It may be even easier to imagine a day when the U.S. runs short of electric power because the power companies have not provided the capacity. It is the utilities, not the regulators, that will be held responsible, though they can hardly be expected to commit stockholders' funds to projects the commissions have demonstrated they're not prepared to finance through the rate structure. Rate shock has already provoked some politicians to urge utility takeovers, and we have been so seduced by the mythology of TVA that a power crisis would almost certainly generate widepsread sentiment for state or local takeover of the electric power companies.

And, of course, the situation is a continuing one. The cost of maintaining the industry's existing nuclear plant is considerable, running to the tens of millions of dollars per unit each year, and such costs continue to be compounded by the second thoughts of the safety-oriented NRC_a process that may accelerate in the years ahead as the NRC becomes more concerned with assuring the safety of existing plants than the integrity of those yet to come. And looming ahead are the problems of waste disposal and plant decontamination, whose costs and problems have yet to be resolved. I think the general concern about safety will slowly abate as these plants establish a safety record, but the industry had better be sure that they do that. The accident at the Davis-Bessie plant this spring is not exactly encouraging, and the industry had better be sure that another accident like Three Mile Island does not occur.

Someday the considerable excess electrical generating capacity the U.S. has built up will be exhausted, and the U.S. will have to begin building power plants again_most likely large central-station power plants, however romantic it may be to think that power production could become a cottage industry. It may well be that nuclear power is ill-suited to the energy demand patterns of the years ahead, and it may well be that the alternatives will prove more attractive. But I would hope that nuclear power would be one of the options we'd have, even if it proves to be an option we decide not to exercise. There's obviously a lot to be said for a technology that has delivered the costs it was supposed to deliver almost everywhere else in the world_and done so without raising any serious question about the safety of the plants.

In some respects the years ahead look less difficult for large capital-intensive projects than the late Seventies and early Eighties were. Inflation has subsided considerably, and so has the level of interest rates. At the same time, the prospects for electrical demand growth have subsided considerably as well, and this should ease rather than aggravate the industry's problems.

To revive the nuclear option, however, much will probably have to change. Utility executives will have to be assured that they can bring new nuclear plants into operation at some reasonable cost and within reasonable time periods. They must also be assured that they can recover, again within a reasonable time period, the investments that they will have to make in mounting these plants. To accomplish that a number of societal conflicts will have to be resolved, and I'm not sure that they can necessarily be resolved through legislation.

Other countries have taken other approaches to the problem. The French permit no public participation in the regulatory process once the project gets under way. The Canadians go one better and permit no direct public particpation at all. But both are basically government programs.

Nuclear power ran into plenty of opposition in Japan, but the program did not move ahead until the Japanese had reached a consensus about what ought to be done. Such an approach requires patience and good will, but it accords with the American tradition, and if it means some projects never get built, that may be better than spending 16 years fighting the opposition every step of the way and still not being able to get a multibillion-dollar plant into operation when it's completed, never mind into the rate base.

I'm not sure that the first priority of the utility industry shouldn't be learning to manage the opposition more effectively. In the past, the industry has often seemed to have a genius for polarizing its opposition. Until the mid-Seventies, the industry never questioned its commitment to serve, its absolute obligations to provide power no matter what the obstacles, and it sometimes pursued that commitment with a righteousness and arrogance that provoked a righteousness and arrogance every bit as unbending among its opponents.

Standardized design of nuclear plants is considered the great panacea these days, something the NRC could approve once and for all, and so end all those rework and quality concerns, those costs and delays, the hassles over construction permits and operating licenses, at what could well be a considerable saving. Standardization has drawbacks, however. It freezes in design defects as well as solutions, and it tends to discourage innovation, and, of course, the large reduction in production costs the electric power industry made in the Fifties and Sixties stemmed from continuing innovation in design, pushing to the frontiers of generating efficiency.

And standardization of design may not ensure standardization of constuction. Indiana Public Service's Marble Hill and Commonwealth Edison's Byron plants were twins, but what made Byron a success and Marble Hill a failure was not the standardized design, but the managerial talents of the companies that undertook them. Management talent, or the lack of it, is what accounts for much of the difference between nuclear power plant's costs. Even with standardized designs and probably modular construction, you won't necessarily produce a standardized product. You won't be building nuclear plants like automobiles. They're going to be built with local crews and local managers, even if under the direction of large national agencies.

And standardization will do nothing to solve the problems created by the structure of the industry. To the industry's dismay, the local regulatory commissions have already begun taking a more active role in the regulatory process, but though there's something to be said for this in theory, the commissions are going to have take a more responsible stance than they have done so far, sharing responsibility for the decisions made with their tacit approval: Find a way of coping with the financing costs of large long-term projects, whether through the inclusion of Construction Work in Progress in the rate base or some other mechanism. Most important of all, they are going to have to assure the utility that the funds they commit in the public interest can be recovered by their investors, even if something goes wrong.

Nuclear power will continue to need economies of scale to be competitive, and so, at a time when growth in demand seems to have slowed, this means that even large utilities may have to pool their resources in joint ventures, regional companies, and generating companies, in order to balance capacity with consumption. But that may be a utopian notion. Even forgetting that the courts may be making such arrangements impractical, they would inevitably involve crossing state lines and bring on regulation by the federal government rather than the states, and so aren't likely to be viewed favorably by the states, who see their own regulatory prerogatives under attack.

And so, legislation could conceivably ease the future development of the commercial nuclear power industry, though whether Congress should attempt to do so is another question.

You might prohibit any intervention in the regulatory process by the public at large once a nuclear power plant construction permit is issued.

You might limit design changes once a nuclear power plant construction permit is issued to those whose additional costs can be justified by their benefits, with the NRC bearing the financial responsibility for any increase in cost such changes would entail.

You might vest all regulatory control over nuclear power generation in the federal government, including the setting of rates at a level high enough to assure the recovery of costs. Or failing that, require that local regulators take the responsibility for approving new plant construction and then guarantee that rate increases will be forthcoming to finance recovery on a timely basis of the funds committed to such new plant construction.

I'm not sure, however, that if such legislation is needed to assure the future viability of the nuclear power industry, nuclear power is necessarily worth the price. Maybe what is needed most of all is a reconstituted NRC_or some sort of independent collateral agency_with a commitment not simply to assure safety and quality, or even to set standards and codes for nuclear construction, but with a responsibility to set the direction for the industry and encourage its development. That's what the industry has had in almost every other country in the world, and once had here. I don't see why it can't have it again, and have it without the government assuming the responsibility for managing the program itself.

Only such an agency would be capable of resolving the conflicting interests that are responsible for much of the present impasse, the conflict between consumer interests and those of the community at large, corporate interests with those of the state, state interests with those of the federal government.

These conflicts are not limited simply to nuclear energy. They are conflicts that are coming increasingly to paralyze the electric power industry no matter what its energy source. Such conflicts conceivably can't be resolved. But if they can't be, our society is in trouble. Because clearly energy is going to be vital in keeping our economy going in the future, and unless somebody comes up with a water engine one day soon, electric power_and one might hope nuclear electric power_is going to be one of the principal ways we're going to produce it.

(COMMITTEE NOTE.--The article entitled, "Nuclear Follies" by James Cook appearing in Forbes Magazine, February 11, 1985, was placed in the files of the subcommittee.)

STATEMENT OF GORDON COREY

Mr. COREY. Thank you, Mr. Chairman. I am delighted to be here and to be able to follow such a competent witness as Mr. Cook. I am appearing today at your invitation and on my own behalf, although I was associated for 45 years with Commonwealth Edison Co. of Chicago, the Nation's leading nuclear utility.

I make just six points. One, I am a financial man, not a lawyer or nuclear engineer. I know from experience how uncertainty and delay can frustrate project financing. Anyone who has financed a large construction project knows that time is money, that frequent design changes inevitably cause delays, and that prolonged delays cause excessive cost overruns which can make financing impossible.

A good example of what can happen is provided by Chicago's John Hancock Building whose initial developer, Jerry Wolman, went bankrupt when construction delay of only a few months wiped out his equity and left the project unable to service its debt.

Point No. 2 of my six points. Stability and certainty must be restored to the nuclear licensing process, and frivolous intervention must be minimized. Otherwise, it will be impossible to finance privately any new nuclear plants.

Three, based on repeated analyses of comparative generating costs throughout 20 years, I am convinced the nuclear option should remain available as we thread our way through a future obstacle course strewn with concerns over oil supplies and acid rain.

Four, the nuclear option is slipping from our grasp. Nuclear power is still economical—in that I disagree slightly with Mr. Cook—and nuclear plants now under construction should certainly be completed.

But I, myself, would not order a new nuclear plant today, even if I had authority to do so, because of the risks and uncertainties occasioned to an important degree by an unworkable, adversarial system of licensing and legal intervention.

Five, in my opinion, it would be impossible to finance privately a new U.S. nuclear powerplant ordered today, because of those regulatory and legal risks.

Finally, point No. 6, I urge this committee to act promptly to enact a system of one-step licensing of standardized nuclear plants with limitations on frivolous intervention. Time is of the essence. Your failure to act promptly will be a decision to kill the nuclear option. In that I agree completely with what Mr. Swidler had to say.

This committee should decide now and promptly whether it believes the nuclear option should be preserved.

Mr. Chairman, I have been active in the utility financing world for 45 years. I became the chief financial officer of Commonwealth Edison 25 years ago. I have advised Bechtel and others on project financing matters over an extended period of time. I believe my financial credentials will bear scrutiny. And I am concerned that how nuclear plants cannot be financed under the present situation. That is, new nuclear plants starting from scratch today.

I hope you will put my prepared statement in the record, and I thank you for inviting me.

Mr. **Bryant**. It will be placed in the record. Thank you. Mr. Sillin.

[Statement of Mr. Corey follows:]

TESTIMONY OF
GORDON R. COREY
BEFORE THE
ENERGY CONSERVATION AND POWER SUBCOMMITTEE
OF THE ENERGY AND COMMERCE COMMITTEE
U.S. HOUSE OF REPRESENTATIVES
JULY 25, 1985

I am appearing today at your invitation and on my own behalf, although I was associated with Commonwealth Edison Company of Chicago for 45 years. Commonwealth is the leading U.S. nuclear utility with 12 large nuclear units -- nine in operation and three more under construction. I personally negotiated the purchase of the first four of these units; the other eight were purchased under my general direction. The nine units which are operating today are generating nearly a billion kilowatthours a week, just under 2% of all U.S. electric power output, at significant savings to Chicago area electricity users.

Today, I wish to cover five points which are generally addressed to the questions raised by the Committee. These five points are:

(1) How regulation and litigation have exacerbated the financial difficulties of nuclear utilities.

(2) The cost of nuclear construction delays.

(3) The financial consequences of construction cost overruns.

(4) The cost of litigation.

(5) What should be done?

I. How regulation and litigation have exacerbated the financial difficulties of nuclear utilities

In the 1950's and 1960's, I watched the exciting early development of civilian nuclear power, both here and abroad, with U.S. technology providing the leadership for that worldwide development.

In the 1970's and 1980's, I watched as that development was slowed down and finally halted (in the U.S. but not abroad) through a combination of factors, including the development of a cumbersome regulatory system which has extended construction schedules, precipated a flood of design changes, and introduced enormous uncertainties into the licensing process, including those occasioned by repeated legal interventions which would stifle any technology.

Cumbersome regulation and dilatory litigation have not been the only factors inhibiting the development of nuclear power in the U.S. Load growth anticipated in the 1970's did not materialize. Inflation and higher money costs contributed to construction cost overruns and thus to the reluctance of public utility commissions (PUC's) to raise rates. Some utilities should not have undertaken nuclear projects. Some manufacturers and construction contractors made mistakes.

None of us are completely without blame. However, by unnecessarily extending construction schedules, regulation and litigation have multiplied the effects of inflation and higher money costs. By adding to the cost of construction, regulation and litigation have made overbuilding more expensive. By significantly increasing uncertainties, regulation and litigation have exacerbated financing difficulties for those utilities struggling to complete their nuclear power projects.

I am a financial man, not an engineer. I know from experience how uncertainty and delay can frustrate project financing. Indeed, anyone who has financed a large construction project knows that time is money, that frequent design changes will inevitably cause delays, and that prolonged delays will cause excessive cost overruns which may make financing impossible. A good example of what can happen is provided by the John Hancock Building on Chicago's near north side. In the 1960's, Jerry Wolman, the developer who initiated that project, was forced to seek bankruptcy protection when an unexpected construction delay of only a few months wiped out his equity and left the project unable to service its debt.

In the nuclear power field, construction schedules have been subjected to repeated and unpredictable regulatory interruptions and delays. Hundreds of mid-stream changes in plans and specifications, many of which resulted in extensive construction rework, have been imposed by the regulatory staff without weighing the overall contributions to public safety against the costs and other penalties.

Again and again, construction managers have been forced to accept changes they feel are both unnecessary and unwise to satisfy regulatory whims and avoid still further delays.

Not surprising, all this has resulted in enormous cost overruns and serious financial stress for the utility owners.

II. The cost of nuclear construction delays

The cost of construction delays is especially significant when interest rates are in the double digit range, as they have been in recent years. With money costs of 15% a year, an investment doubles in five years and quadruples in ten.

The cost of construction money is known to utility people as AFUDC -- the capitalized cost of funds used during construction, sometimes simply called "interest during construction."

When a nuclear plant is delayed, after considerable amounts have been invested, AFUDC costs go through the roof. This is an important reason why some problem plants like Shoreham and Nine Mile Point, which were subjected to prolonged delays late in the construction period, are expected to cost over $4,000 a kilowatt, more than double Commonwealth's Byron and Braidwood cost and treble that of its LaSalle Station. For some problem plants, the AFUDC component alone may approach

$2,000 a kilowatt, compared with about $650 for Byron and Braidwood and only $250 for the earlier LaSalle units.

The comparison is even more striking when one examines earlier plants having much smaller AFUDC components. The Dresden, Quad Cities and Zion units, which Commonwealth completed in the early 1970's after construction periods of only five or six years, had AFUDC costs of only $18, $22 and $45 per kilowatt, roughly 10% of that for LaSalle, 5% of Byron and Braidwood and 2% of Nine Mile Point.

It seems clear that the significantly higher AFUDC accumulations for today's plants, have resulted directly from construction delays and that the cost of such delays accounts for a large share of the recent nuclear construction cost overruns.

A good deal of these delay costs must be laid at the feet of our unworkable regulatory system.

III. The financial consequences of construction cost overruns

The nuclear plant construction cost increases of recent years have resulted in serious financial stress for many of the utilities which own such plants.

Let me explain why. Delays and construction rework inevitably increase the cash requirements and force the owner to seek additional outside financing. In the absence of substantial rate relief, which PUC's are often reluctant to grant, the quality of earnings deteriorates and debt coverages decline. These are reflected in lower stock prices and higher borrowing costs, which strain the owner's ability to finance. As a result, the owning utility may eventually find itself foreclosed from the capital markets and forced to suspend work. Some utilities have been forced to abandon their nuclear power plant projects altogether -- with billions spent but not a single kilowatt of generating capacity to show for it.

IV. The cost of litigation

My fourth point relates to the cost of virtually unrestricted intervention -- the cost of redundant adversarial review -- the cost of repeatedly examining why the decision to build the plant was made in the first place. Such litigation customarily involves prolonged interrogation and cross examination of construction managers and field engineers who should be overseeing the job. It is akin to interrupting surgery in order to argue with the surgeon, while the patient lies unconscious on the operating table. In my opinion, the virtually unlimited access of intervenors to the regulatory process has needlessly prolonged those delays already present in the regulatory system itself.

V. What should be done?

I am not an expert on licensing procedures and cannot suggest specific statutory language. From my long-term perspective as a financial executive, however, it seems clear that certainty and stability must be restored to the licensing process or we will never be able to finance another privately-owned nuclear power plant in this country. We can surely do this while, at the same time, preserving and enhancing those public health and safety objectives which licensing was designed to protect.

Unlike overseas, the U.S. licensing process is now conducted in an adversarial environment which encourages frivolous intervention and thereby frustrates timely and efficient construction. Safety is best enhanced through carefully considered oversight by a competent team of experts -- not by the pushing and shoving of a crowd of self-serving adversaries.

Too often, intervenors in licensing procedures are interested in stopping the project rather than enhancing its safety. There is little evidence that today's system of wide-open intervention inspires confidence in either the regulatory process or the technology, as was intended by the drafters of the Atomic Energy Act.

SUMMARY

I have watched with dismay while an unworkable regulatory system has evolved for nuclear power in the U.S.

I have watched the emergence of a public witch-hunt mentality in our country, while France, Japan, Russia, Korea, Taiwan and others have moved steadily forward, installing nuclear power plants with relative ease, in substantially less time and at lower cost than is possible here, often using American technology and sometimes employing American construction firms. This suggests that the overseas advantage is clearly not in technical know-how or managerial competence but that something is seriously wrong with the American regulatory system.

The nuclear power option should still be available for new power plant construction in the U.S. today, given concerns over acid rain and the future availability of oil. Completion of those nuclear projects which are well along is clearly preferable to their abandonment. Yet the nuclear option is slipping out of our grasp because regulatory uncertainties and potential litigation have made the financial risks too great. It costs too little to litigate. All an intervenor attorney has at stake is his own time, but the delays induced by his intervention may threaten the owner of the plant with bankruptcy and saddle ratepayers with much higher electricity costs.

In short, for utility managers planning new power plants for the future, the nuclear game is no longer worth the candle.

To summarize the situation, let me quote from a March 1984 article by Felix Rohatyn.* Here are three excerpts:

1. "The problems of the nuclear power industry require national attention. From Shoreham, Long Island, to the Pacific Northwest's Washington Public Power company, nuclear power plants costing tens of billions of dollars remain unfinished."
2. "The disasters that overtook the ¼nuclear½ industry had many causes. Dramatic cost overruns were caused by regulatory and judicial delays. Equipment manufacturers and contractors failed to build safely and efficiently; the utility companies were often shortsighted and incompetent. Government oversight was confused and uncertain."
3. "The result, the abandonment of facilities in which vast investments have been made, is an appalling waste. The losses, in the tens of billions, will be absorbed partly by the ratepayers and the stockholders; but in the last analysis, one way or another, taxpayers will foot the bill without having one megawatt of additional power to show for it."

* * * * *

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* New York Review of Books, March 29, 1984

I agree with the foregoing and with Mr. Rohatyn's following suggestions for remedying the situation:

> "An industrial policy dealing with nuclear energy could have avoided much of this and might still bring something out of the current chaos . . . .
>
> "The federal government should have been in a position to insist on standardized design, on tougher oversight of contractors and utility management in both construction and operations. It should not have been necessary for legal proceedings to drag on, and there should have been a more consistent regulatory climate . . . .
>
> "It is not too late to salvage something from the appalling waste existing today by applying these principles to some of the unfinished nuclear projects that are now being abandoned."*

I agree with this. I agree with the need to license standardized plants, preferably in a one-step procedure. And I agree with the need to limit redundant litigation which is designed to delay and frustrate rather than to resolve controversy.

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* These statements were coupled with suggestions for more active Federal participation "in partnership with the states and utility companies," and the encouragement of regional nuclear power development, perhaps with Federal assistance.

A few years ago, in a talk to the Chicago Law Club, I said that it offends my sense of fairness that an adept lawyer can delay a nuclear power project for several months at enormous cost to the general public. Apropos of that comment, the Honorable Ed Austin, Senior Partner of Sidley & Austin (now deceased), wrote me to say:

> "I could not agree with you more except that you said . . . that an 'obscure individual with an irrelevant claim and a most mediocre lawyer could squeeze out a month or two's delay through an appeal.' In my experience, such a combination can get a much longer delay."

In the words of one of our nation's great lawyers, this is exactly what needs to be fixed. We don't need to embargo Japanese and German technology. We simply need to give American nuclear technology a fair chance.

STATEMENT OF JOHN SILLIN

Mr. Sillin. Thank you. My summary statement basically is going to be directed at the point that not only is the nuclear option going to be desperately needed in the very near future, but that continuing economic developments are going to dictate that it is the way to go. And that actions by Congress, by this subcommittee, can be taken to push that in the right direction.

Why is the nuclear option needed? Demand for electricity is once again increasing due to a resurgent economy. This is in comparison with the stagflation of the 1970's. This resurgence in electric demand is also a result of its increased price competitiveness of electricity versus oil, natural gas, and other energy alternatives, that is, electricity is gaining market share.

Electricity demand is now increasing at average annual rates of between 4 and 5 percent. This translates into order requirements needed to meet this growth of between 30 and 50 gigawatts per year. All the cogeneration in the world will not get you close to that amount on a sustained basis.

Why then is the nuclear option the way to go? Why is it economic? Generally there are some things happening on the economic scene which I think have the potential to improve nuclear economics.

First, low inflation rates and declining interest rates have the potential of making the nuclear option, one, the economic way to go by reducing construction costs; and, two, affordable.

Again, the looming electricity crisis also has the potential of beginning to force efficiencies into both the construction process and the licensing process, thus reducing load times. In this regard, H.R. 1029 is a positive step. I think your hearings today also reflect a deepening awareness of this looming electricity issue, and that something needs to be done to make nuclear a part of the solution to that issue.

Given a stable licensing environment, stable economic conditions, nuclear is, I believe economic analysis show, the way to go. According to my own calculations, assuming a 5- or 6-year construction leadtime and inflation at 4 percent, you can build nuclear powerplants in the mid-1990's at $2,000 a kilowatt or less. This is equivalent to the cost of plants—the average cost of plants coming on line today.

But again, no one is going to take these steps unless there is stability in the licensing process. Again, standardization, as encouraged via passage of H.R. 1029, is a positive step in making that happen.

Other things working toward making nuclear the economic way to go is that nuclear fuel costs are declining. There is essentially a glut of uranium ore and enrichment capacity these days. As a result, nuclear fuel costs should be declining through the rest of this decade and into the 1990's.

Under the above conditions, nuclear power is, by any stretch of the imagination, superior to any other alternative, that is, it is 40 to 50 percent more economic than the next best alternative, which is coal.

Another development, which I think will make the nuclear option more attractive, is this emerging movement toward deregulation, where an investor, if he takes a risk has the opportunity to pass some of those economic benefits on to the shareholder, instead of passing them completely on to the ratepayer, which exists at the present time.

Recommendations that I offer to you include strong support of the standardization effort of this subcommittee and of the bill, H.R. 1029.

Other things which I think can be done to encourage the development of the nuclear option, that is to make it part of the solution to the emerging electrical shortage, is to essentially deregulate the wholesale power markets.

I mentioned the emerging deregulation movement. Under a deregulation scenario, new capacity of any type would not be subject to pricing formulas. It would include both centralized as well as decentralized options, and will result in true competition among the various alternatives. Again, centralized as well as decentralized options would be included.

Also, as the electric industry restructures to take advantage of free market opportunities, State commissions would be forced to change those policies which are anti-utility. All of this would work toward revitalizing the nuclear option if its relative economics are as attractive as indicated in my statement.

Finally, deregulation is a logical extension of PURPA, which deregulated small-scale, third-party electricity generators. Regarding this legislation, utilities are required to buy any and all output from third-party producers. Provisions supporting this should be repealed, because it guarantees a return to investors no matter what the economic merits of the project.

This, combined with deregulation of bulk power sales, would put nuclear and other supply technologies on an equal competitive footing and let the market determine which is the economic way to go.

Thank you.

Mr. BRYANT. Thank you very much. Mr. Rowden.

[Statement of Mr. Sillin follows:]

Summary of Statement by John O. Sillin
to the House Subcommittee on
Energy Conservation and Power

July 25, 1985

The attached statement describes in considerable detail that the demand for electric power will increase significantly from current levels thus necessitating the need for new capacity, and that nuclear power will be an attractive option for satisfying much of these new capacity needs.

The demand for electricity will increase because of a resurgent economy - versus the stagflation of the 1970's - and electricity's increasingly competitiveness compared to oil and natural gas. Attached to my full statement are two articles I coauthored in the Wall Street Journal and the New York Times describing this development.

Improved economic conditions will also work to nuclear's advantage. Reduced inflation and interest rates will reduce nuclear construction costs from today's level, and as the need for power issue looms regulators and nuclear plant owners will further improve construction and operating management practices, thus reducing lead times and further reducing costs. That these efficiencies can be achieved is described in an article - also attached to this statement - I recently had published in Public Utilities Fortnightly.

My overall recommendation is for the subcommittee to encourage administrative actions by the Federal Energy Regulatory Commission, and legislative action in the case of the Public Utilities Regulatory Policies Act, which further free-up the electricity markets. In addition, passage of House bill HR 10-29, "The Nuclear Power Plant Standardization Act of 1985" would encourage reduced nuclear costs by promoting regulatory stability and design standardization.

In conclusion, an unregulated market in the case of bulk power sales, will result in the application of the most cost-effective electricity techniques - of either a supply or conservation nature. And in such an environment I'm confident that nuclear power will re-establish itself as a preferred generating option.

"Revitalizing the Nuclear Option"

By

John O. Sillin

Alexander Grant & Company

Presented to the House Subcommittee on Energy
Conservation and Power

July 25, 1985

The decline of the nuclear power industry has been well documented, and that the nuclear industry's future is bleak is almost a given. Almost because I do not believe it. And in this submission I present reasons for supporting this position. In fact, under the conditions that are evolving those companies who have invested in nuclear power, and who make future investments in it, stand to reap significant financial rewards.

With regard to actions by Congress, the revitalization of the nuclear option can be furthered not so much by passage of additional legislation, but by encouraging the Federal Energy

Regulatory Commission (F.E.R.C.) to deregulate the bulk power sales market thus allowing the interplay of free market forces. Also, the Public Utilities Regulatory Policies Act (PURPA) should be amended such that no investor - - be it in small or large scale projects - - be guaranteed a return. Also, the tax system should be reformed putting central and decentralized generating options on an equal tax status. But, no new government programs or spending is needed. In fact, a reduced presence by the Federal government in the energy markets is the best prescription for nuclear power.

The remainder of this written submission details the conditions under which the nuclear option will once again be found to be attractive, and the policy recommendations just outlined.

1. The Changing Economic Scene

To begin, the economic situation has been fundamentally altered since the "dog days" of the 1970's. The last two and one half years has witnessed a remarkable resurgence in the economy (Exhibit 1). Fourth quarter over fourth quarter real GNP growth approximated six percent in both 1983 and 1984. While economic growth has moderated beginning with the 3rd quarter of 1984, it has nevertheless stayed positive and appears poised for another surge.

This recovery has coincided with and been spurred by several other economic developments.

- Inflation has declined precipitously, and appears to have stabilized at a level below 4%. Money growth has also continued stable indicating that the current recovery is not the "boom-bust" pattern that characterized the late 1960's and 1970's (Exhibit 2).
- Interest rates have fallen. The prime rate has fallen by 10 percentage points since the recovery began, mirroring the improvement in the financial markets. Utilities have benefitted as reflected in their stock price. The Dow Jones utility index has gone from approximately 100 in the late 70's and early 80's to over 160.
- Investment, construction, and research and development spending have moved ahead at record levels, indicating that a solid base is being prepared for sustained economic growth with low inflation (Exhibit 3). Preliminary estimates indicate capital spending will be up between 7 and 10 percent in 1985, thus continuing this trend.

- Employment has also increased at record levels, while productivity has increased significantly. Consistent with this real personal income has increased 10 percent the last two years -- this is among the biggest increases on record, and nearly twice the amount achieved in the 1970's.

These positive economic developments would appear to be a direct result of the administration's tax reduction program, stable money growth policies, and deregulation activities.

In addition, the energy scene would appear to be a positive force on the economy now, versus the disruptive force it was in the 1970's. With oil and natural gas prices for the most part deregulated, supply and demand forces have taken hold. The result, large surpluses in oil and natural gas production (Exhibits 4 and 5), and stable or falling oil and natural gas prices. This condition appears likely to hold through the 1980's. And falling energy prices have the effect of freeing up resources for other consumption and investment purposes, thus acting as a spur to economic growth.

2. The Electric Load Growth Outlook

A vibrant economy, combined with stable electricity prices, has resulted in resurgent electric load growth. Total electric output* was up approximately 3.5 percent in 1983 and 4.6 percent in 1984. Assuming the economy grows at approximately 3 percent in 1985 electric load growth should be up by at least a like amount (Exhibit 6).

The electric output to GNP (EO/GNP) ratio appears to have stabilized at approximately .85 (Exhibit 7). This in itself should result in growth in electric output of 2.5 percent. But 1985 may see the beginning of an upturn in the EO/GNP ratio as a result of significant growth in both real personal income and capital outlays. Rising capital and construction expenditures have the effect of accelerating electricity's growth in energy market share, and rising personal incomes, combined with falling real electric prices, have the effect of increasing intensity of use. In addition, weather effects should give a boost to electric output in 1985. If only normal weather occurs in 1985, electric output should be about one percentage point higher than otherwise.

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*Electric output as used here includes electric utility generation, purchases from industrials (cogeneration) and imports.

As the recovery continues, and the positive economic factors described previously stay in force, the EO/GNP ratio should strengthen (Exhibit 8). Thus, within a year or two electric growth rates are likely to be once again exceeding GNP growth.

As indicated above, the strengthening of the EO/GNP ratio should be further spurred by the stability of electric prices. Since 1982 real electric prices have fallen by approximately 2 percent, and this trend should accelerate as the 1980's progress (Exhibit 9). By 1990 real electric prices should be 10 to 15 percent lower than in 1982. There are many reasons for this.

- Fuel prices will remain stable or fall. It was rapidly rising fuel costs which caused 75 percent of the increase in electricity prices in the 1970's.
- Moderate or low inflation will reduce or eliminate the need to seek rate increases to cover rising operating costs. Reduced inflation also has benefits with regard to holding down construction costs.

- Moderate inflation and the improving tone of the financial markets will reduce or eliminate rate increases reflecting increases in the cost of capital. In fact, conditions have improved recently to the point where most utility stock prices are now selling at book value or higher.

- The increase in electric sales has and will reduce the rate increases necessary to absorb plant additions associated with completed coal and nuclear facilities. In fact, through the rest of the 1980's, load growth should exceed plant additions thus resulting in falling real per kilowatthour fixed costs. This is the opposite of what occurred in the 1970's.

The overall result of continuing economic recovery and stable electric prices is that annual electric load growth should average between 4 and 5 percent for the balance of the 1980's. This has been the case since the recovery began in early 1983. With electric load growing at between 4 and 5 percent the national reserve margin drops below 20 percent between 1988 and 1990 (Exhibit 10). It is at this point that significant reliability problems will likely occur. And utilities and their customers will go to great lengths -- and almost any expense -- to prevent this from happening.

In short, by the late 1980's there will be a seller's market in electricity. Companies which have capacity to sell will be in a strong bargaining position. Thus, those companies which have low cost power generation facilities may be in a position to command large economic rents.

3. Nuclear Power Costs In An Improved Economy

Despite the rate shock rhetoric which is so prevalent, particularly among anti-nuclear advocates, nuclear power remains the most cost effective technology for producing electricity. Even when nuclear plants come in at the high end of the capital cost range they are competitive with coal on a levelized pricing basis. Windmills, photovoltaics and other "exotic" forms of generation still do not compete economically on an unsubsidized basis.

But in the conditions described above nuclear power plants will not cost $3,000 per kilowatt or higher, but more like $2,000 per kilowatt. The nuclear plants coming on line today will likely be the most expensive constructed in this century simply because they took 10 years or longer to build. One third to one half the cost of the facility turns out to be nothing more than capitalized interest -- AFUDC -- when construction lead times are this long (Exhibit 11). The price tag for these plants were also adversely affected by high inflation, high interest rates, and regulatory uncertainties.

But in the current economic era these conditions will not persist. To begin with, construction lead times of between 5 and 6 years are attainable. The French and Japanese regularly hold construction schedules to these lengths. This is in large measure a result of a national political and social committment to the nuclear option. This committment is largely driven by the desire to reduce national dependence on imported oil and gas. While no such commonality of interests yet exists in the U. S. one is in the process of forming, as the need for power issue begins to loom, and it becomes increasingly apparent that non nuclear options cannot do the job of satisfying load growth (Exhibit 12).

Already there are positive signs as exemplified by recent NRC operating license decisions, and the growing pressure on the NRC to change its organization structure and reform its decision making procedures. House bill HR 10-29. "The Nuclear Power Plant Standardization Act of 1985", is a positive step in this regard in that it promotes regulatory stability and design standardization. It is my recommendation that this bill be passed.

Low inflation, and an improved tone in the financial markets resulting in a lower cost of capital, will also work to reduce nuclear construction costs below the levels recently experienced. At the present time inflation is averaging less than 4 percent. And as previously mentioned, utility stock prices have improved to the point that most are selling at or above book value. Finally, nuclear operating and construction management practices have been tightened considerably, resulting in the more efficient use of resources and meeting schedule deadlines.

The effect of these changed assumptions on nuclear power's economics is dramatic. The current dollar costs of building a plant scheduled for service in the early to mid 1990's is $2,000 per kilowatt, or less. That is no higher than the average cost of nuclear -- and some coal facilities -- entering service today. The results, the nominal and real capital costs of nuclear will be falling over the next decade.

When combined with fuel price developments, nuclear power's overall economics approximate those of a run-of-river hydro facility. Each type facility will have large up front capital costs, but operating cost are low. In both cases this is due to the fact that their fuel costs are either low (uranium) (Exhibit 13) or almost non-existent (hydro). With the recent discovery of large high grade uranium deposits throughout the world, the likelihood of uranium prices staying at low levels is high. Also, a glut of enrichment capacity makes future price increases for this service unlikely. Together fuel and enrichment account for the bulk of total nuclear fuel costs.

The result is that combined nuclear owning and operating costs are significantly lower than alternative supply options. The levelized cost of a nuclear facility entering service in the early to mid 1990's is as low as 8.5¢ per kilowatt hour. This price is in current dollars with inflation assumed at 4 per year. For a new coal facility the cost is 12.5¢ per kilowatt hour. And for combustion turbines and combined cycle units running on oil and natural gas the levelized cost approximates 20¢ per kilowatt hour (Exhibit 14).

The levelized cost advantage of new nuclear versus new coal increases to over 45 percent. This compares to the 25 percent to 40 percent advantage recently calculated in an AIF study*. This study assumed an eight year lead time (6 year construction schedule), a nuclear construction cost escalation rate of seven percent and real uranium prices in the 1990's nearly triple today's values. Based on recent economic and fuel price data, the inflation and uranium price assumptions are likely to turn out to be too pessimistic.

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*"A comparison of Future Costs of Nuclear and Coal-Fired Electricity," prepared by a study group of the Committee on Financial Considerations, November 1984, Atomic Industrial Forum, Inc.

When nuclear's economics are compared with windmills, low head hydro, and PURPA induced cogeneration it is difficult to put them all on the same chart because of the latter three alternatives high cost.

Even when one compares nuclear with run of river hydro (in effect imports from Canada) the results are likely to be favorable toward nuclear. Nuclear can be located relatively close to load centers, while new hydro must be built in wilderness areas which are at a minimum hundreds, and in Canada's case, a thousand miles or more distant. This, in turn, necessitates large transmission facility investments -- a cost which in the case of nuclear is significantly less. Thus, the capital and operating costs associated with these transmission facilities tends to negate any cost advantage hydro may have with respect to the actual power production facility.

Finally, the greater the delivery distance, the less reliable the grid. This is a non-economic factor, in the case of Canadian imports, which works to nuclear's advantage.

4. Attractiveness of the Generating Company Concept

As indicated earlier, by 1990 those companies which have low cost power generation facilities may be able to command large economic rents. Already these are indications that this will be the case.

Manitoba Hydro is developing hydro facilities to meet the growth of utilities located in the Mid West and Great Plains regions. This power will be sold at a rate approximately equal to the cost of generating power from coal. And if the levelized cost of a new coal facility in the 1990's approximates 12.5¢ per kilowatt hour, and the cost of the hydro generated power is equivalent to new nuclear -- 8.5¢ per kilowatt hour -- it is obvious that Manitoba Hydro stands to realize a dramatically high return on its investment.

Similarly in New England, the cost of purchases from Hydro Quebec will be 80 percent of the average price of generating with fossil fuels. If demand growth in New England continues to race ahead thus requiring the increased use of oil and gas fired facilities, the New England power pool's average fossil fuel cost will rise, and so will the returns to Hydro Quebec.

Even in the U. S. significant financial returns have been achieved through sales of bulk power. The Southern Company, for example, has bolstered its bottom line by selling large amounts of excess coal capacity to utilities in Florida, and Louisiana and Texas.

In line with the above examples, the generating company may be the vehicle through which investors can achieve significant financial returns from nuclear projects. A generating company would be a seller of bulk power, thus putting it under the jurisdiction of the FERC. Precedent, as illustrated by the above and other examples, indicates that the FERC allows prices to be set closer to the marginal cost of electricity, versus rates set by state regulatory commissions.

In fact, it is current state rate regulatory policies which may encourage the development of generating companies. Utilities will be hesitant to invest in large economically efficient base load facilities given the recent history of state rate regulatory decisionmaking. Various state rate commissions have effectively confiscated utility shareholders of their investment by forcing them to bear most or all the risk associated with power plant construction. Forcing utilities to capitalize the cost of interest during construction, and not allowing utilities a fair return on this investment at completion, are examples. Given the economic turbulence of the period between

1968 and 1982 these risk allocation procedures were obviously unfair.

But a generating company can bypass state PUCS, and appeal directly to the Federal regulators (Exhibit 15). And as implied earlier, already flexible rate regulatory procedures will increase as the need for power issue grows. In addition, state PUCS and utilities will lose bargaining leverage as their alternative supply options decrease.

With nuclear generating costs as much as 40 percent lower than the next best alternative (i.e., new coal-fired generation) the potential returns are obviously quite large. If the generating supply option turns out to be combustion turbines, or some other oil and natural gas fired alternative, the cost differential turns out to be approximately double. If only a portion of this economic rent is realized the returns to generating company participants would appear to be extremely attractive -- exceeding the return on all but the most speculative investments.

5. Generating Company Participants

In order to prevent a nuclear generating company from becoming a speculative enterprise participants should include organizations with well tested technical and marketing skills, in addition to having adequate financial resources (Exhibit 16).

The first candidate to come to mind for participation in a generating company are electric utilities, either singularly or in combination. But, while utilities have formed generating companies in the past their distribution investments, thus their continuing to be subject to state PUC regulation in some form, has constrained profit potential. In effect the state PUCS can still hold electric utility investments hostage via the rate making process.

Consequentially, in the future it may be that third parties with little or no stake in distribution would be natural generating company participants. Organizations with the requisite skill and financial resources include vendors, constructors, and architect engineers. Even the financial community could participate by putting together an investment consortium to finance all or some portion of various nuclear facilities. The fundamental point is that they would be separate and independent from the current utility industry structure, thus the only constraint on their bargaining position would be electricity market conditions.

In addition, it is not inconceivable that major oil and natural gas producers -- who have large cash flows, but limited investment opportunities since their traditional business sector is in decline -- may view the electric generating company concept as a growth opportunity. They would be diversifying into the growth segment of the energy business, and could bring to bear large technical and financial resources.

6. Opportunities

As the economy and electric growth continue, profitable opportunities to implement the generating company concept should proliferate. The key to making it succeed is identifying or planning for the right facility in which to participate, and choosing a location where transmission wheeling will be at most a modest bargaining constraint (Exhibit 17).

Initially, opportunities associated with buying into existing nuclear facilities should be investigated. There is now a buyer's market with respect to generating facilities. Many utilities who have just completed, or are still in the midst of major construction projects are financially exposed, and may be receptive to a sales arrangement on the buyers terms. In addition, the stance many rate regulatory commissions have taken with respect to the construction of large nuclear projects enhance the likelihood of good deals being available.

But, this situation will not last indefinitely. The continuation of recent sales trends will soon reduce the amount of plant the owning utility will be willing to sell as future reliability concerns become an issue. The cost of capacity offered for sale is also likely to grow as the number of potential buyers increase. In addition, increased sales will improve the building utility's financial position -- a condition already developing -- thus relieving the utility of the pressure to sell.

Resuscitating deferred or cancelled projects would also appear to be a potentially attractive opportunity. The conditions which should underlie this include that at least site selection be completed, the engineering be usable, and licensing approvals if not already in hand be well along in the review process. Given the current "white elephant" attitude regarding projects in this category it may be possible to purchase them at a steep discount. But again, it is imperative that satisfactory wheeling agreements be negotiable which give the new owners the flexibility to sell to more than one potential buyer.

The third option to be considered is undertaking a completely new project. As indicated earlier this could also be a cost-effective strategy. While there are obviously greater uncertainties than buying into an existing project, under the conditions outlined earlier it is possible to build a nuclear facility -- inclusive of financing costs -- for $2,000 a kilowatt. And this is in current dollars.

READEX
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There is no doubt that considerable risks and efforts are required to make the nuclear generating company concept work. Critical factors to be considered include:

- Cost and financing
- Facility location
- Participants; who they are and their role
- Organization and Contractual arrangements
- Regulatory constraints

But if electricity is a growth industry as is becoming increasingly apparent, the potential upside returns are significant and those who are first stand to harvest the largest returns.

6. Policy Recommendations

As indicated at the outset of this submission, constructive activities with regard to nuclear power's revitalization focus on encouraging the interplay of free market forces as it applies to electricity.

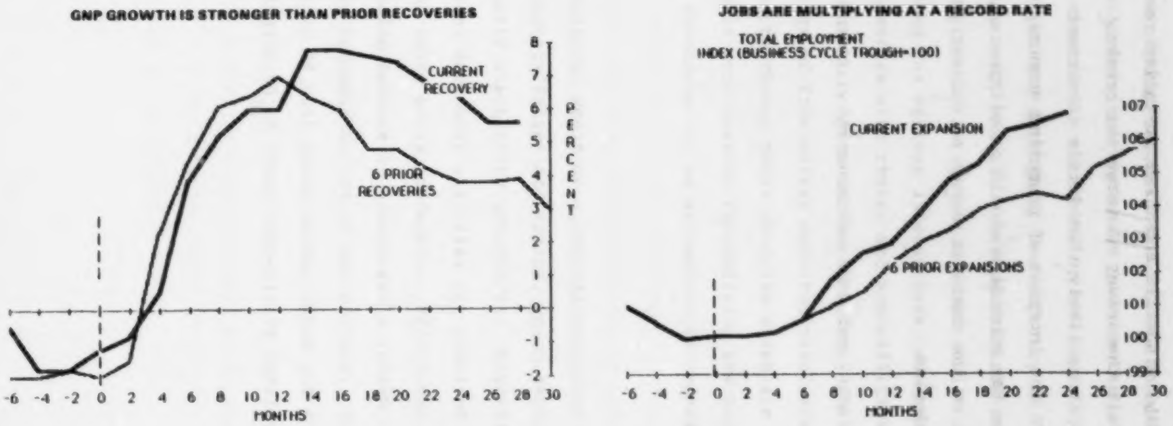
Of the highest importance, Congress should encourage the F.E.R.C. to deregulate the wholesale power market. Specifically, the price for electricity generated by new capacity should not be subject to any pricing formulas. New capacity is defined to include nuclear, coal, and all other centralized as well as decentralized options. Deregulation would result in true competition among the various alternatives, rewards to investors would be commensurate with risks, and non-utilities would be encouraged to invest. Also, as the electric industry restructures to take advantage of free market opportunities, state commissions would be forced to change those policies which are anti-utility. All of this would work towards revitalizing the nuclear option if it's relative economics are as attractive as indicated in this statement.

Deregulation would be a logical extension of the Public Utilities Regulatory Policy Act (PURPA) which deregulated "Small Scale" third party electricity generators. Regarding changes to this legislation, currently utilities are required to buy any and all output from third party producers. Provisions supporting this should be repealed because it guarantees a return to investors no matter what the economic merits of the project. This, combined with deregulation of bulk power sales, would put nuclear and other supply technologies on an equal competitive footing.

Finally, windmills and other so-called renewable supply options can avail themselves of large tax breaks. Without these tax subsidies, it is likely that little investment would occur in them. Thus, in the interest of promoting economic efficiency and fairness, these tax subsidies should be eliminated, and the renewables put on the same tax status as nuclear and other central station technologies.

Thank you, and this concludes my written statement.

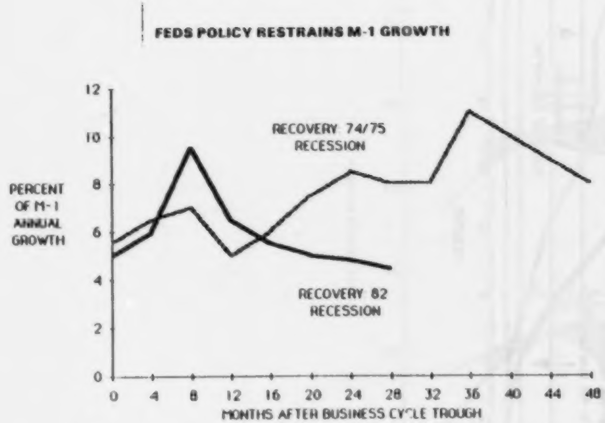
EXHIBIT 1



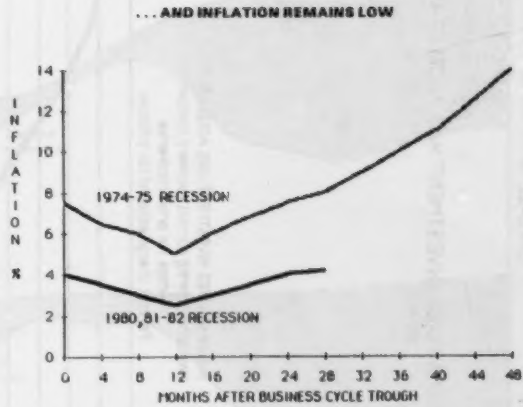
GNP GROWTH IS STRONGER THAN PRIOR RECOVERIES

JOBS ARE MULTIPLYING AT A RECORD RATE

EXHIBIT 2



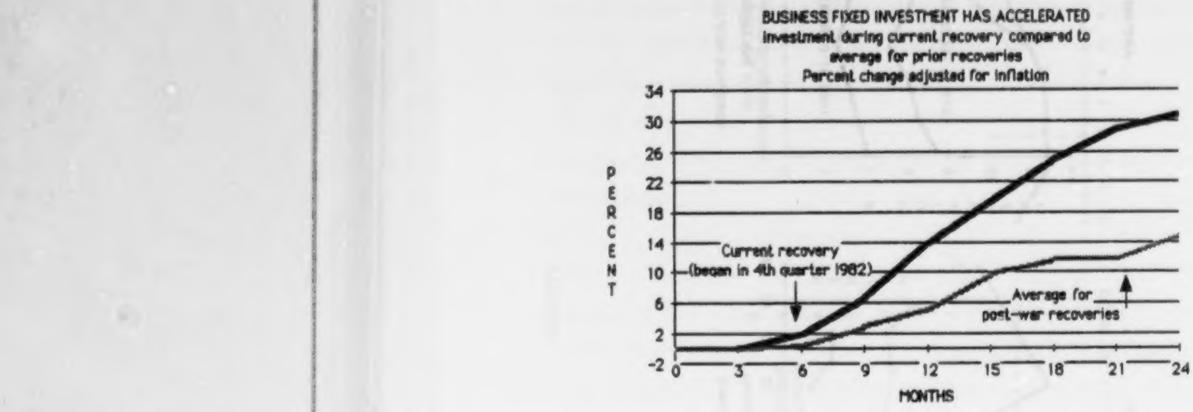
FEDS POLICY RESTRAINS M-1 GROWTH



. . . AND INFLATION REMAINS LOW

EXHIBIT 3

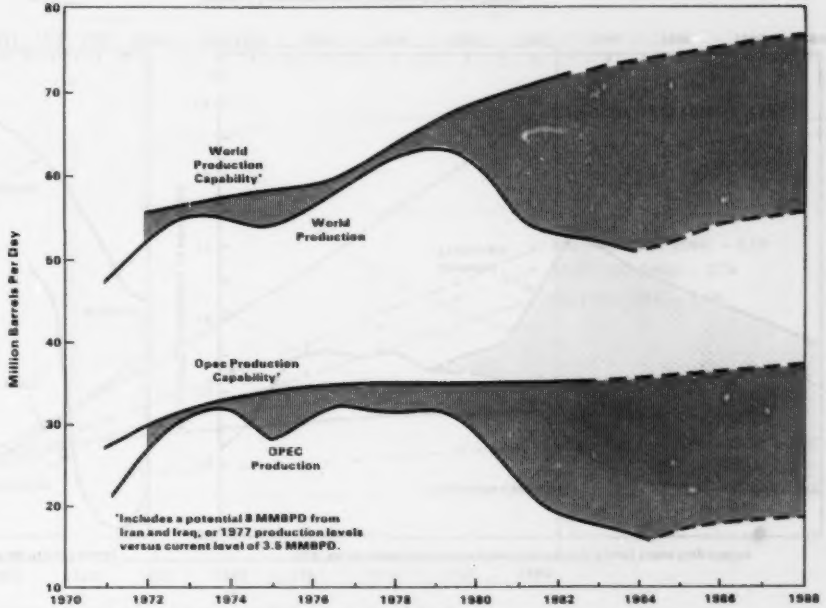
BUSINESS FIXED INVESTMENT HAS ACCELERATED



BUSINESS FIXED INVESTMENT HAS ACCELERATED
Investment during current recovery compared to average for prior recoveries
Percent change adjusted for inflation

EXHIBIT 4

THE PRESENT SURPLUS IN WORLD AND OPEC OIL PRODUCTION CAPABILITY GREATLY EXCEEDS THAT WHICH FOLLOWED THE 1973 OIL CRISIS

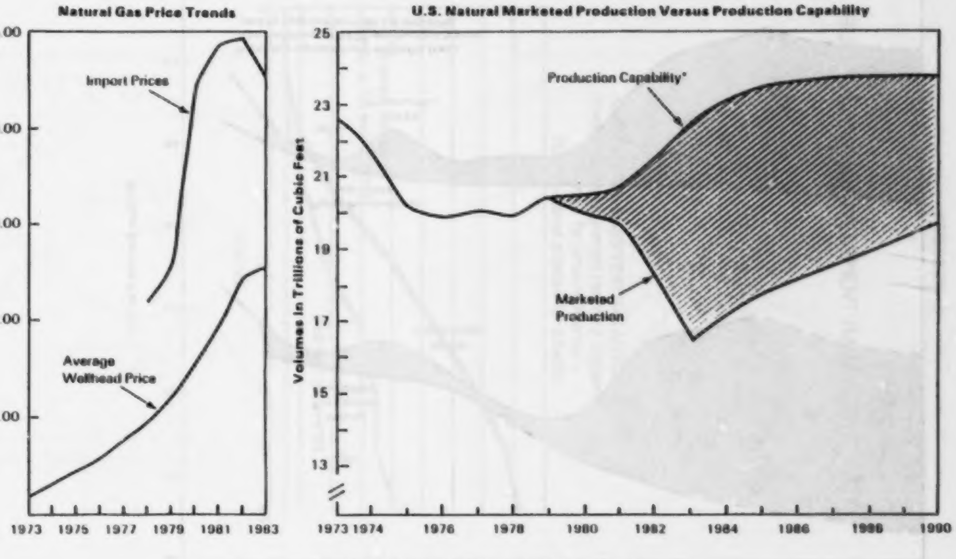


*Includes a potential 8 MMBPD from Iran and Iraq, or 1977 production levels versus current level of 3.5 MMBPD.

Sources: "World Energy, The Facts and the Future," D. Hedley (1981); "Energy and the Developing Nations," proceedings of EPRI Workshop, Hoover Institution, Stanford University, P. Auer (1980); "DOE Monthly Energy Review"; *Economist*, March 27, November 20, and December 11, 1982.

EXHIBIT 5

AS WELLHEAD AND IMPORTED NATURAL GAS PRICES ROSE A NATURAL GAS SURPLUS DEVELOPED WHERE PREVIOUSLY THERE HAD BEEN CURTAILMENTS

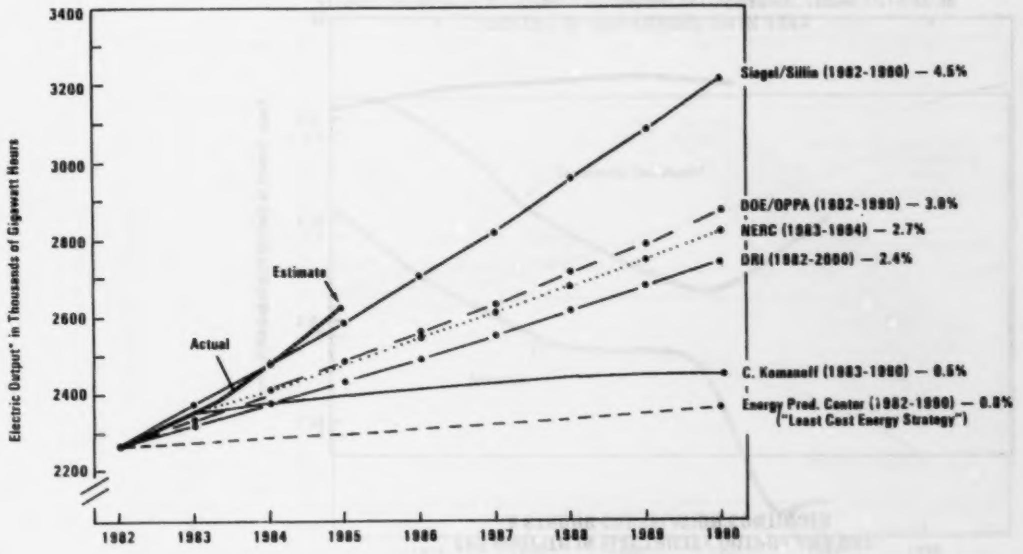


*Includes 1.7 trillion cubic feet of import capability from Canada

Sources: DOE Monthly Energy Review, DOE Natural Gas Annual Review, The Gas Energy Demand Outlook: 1984-2000, the American Gas Association

EXHIBIT [illegible]

COMPARISON OF PROJECTED GROWTH IN ELECTRIC OUTPUT

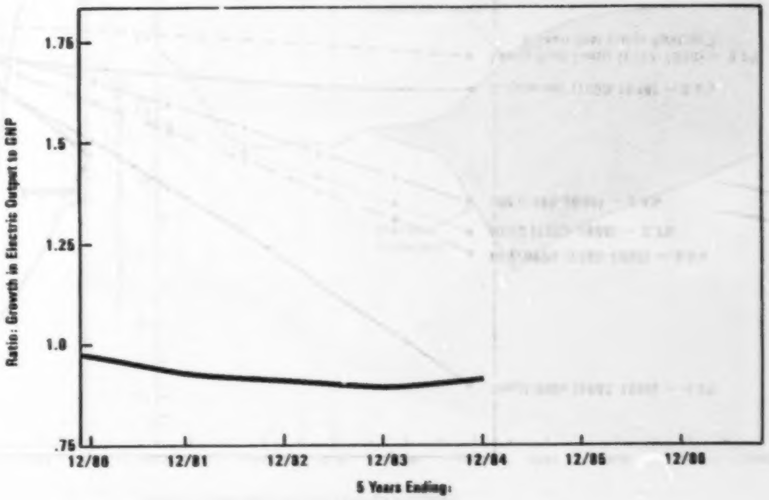


*Electric Output: Total electricity made available for consumption; for EEI "Total Source," Quarterly Report.

NOTE: Due to difficulties in identifying the first forecast year of each projection, and the fact that some projections are changed on an annual basis, 1982 was assumed to be the base year. Exceptions: NERC and C. Komanoff, whose base year was determined to be 1983; 1985 point is an estimate and assumes 6% growth. Sources: Energy productivity center estimate taken from "Eight Great Energy Myths," R.W. Sant and D.W. Bakke, 1981 (Note: 0.8% not a "forecast," but a discussion of a possible outcome if "technology applied on a basis of economic self interest"); C. Komanoff, from Nucleonics Week, 10/84.

EXHIBIT

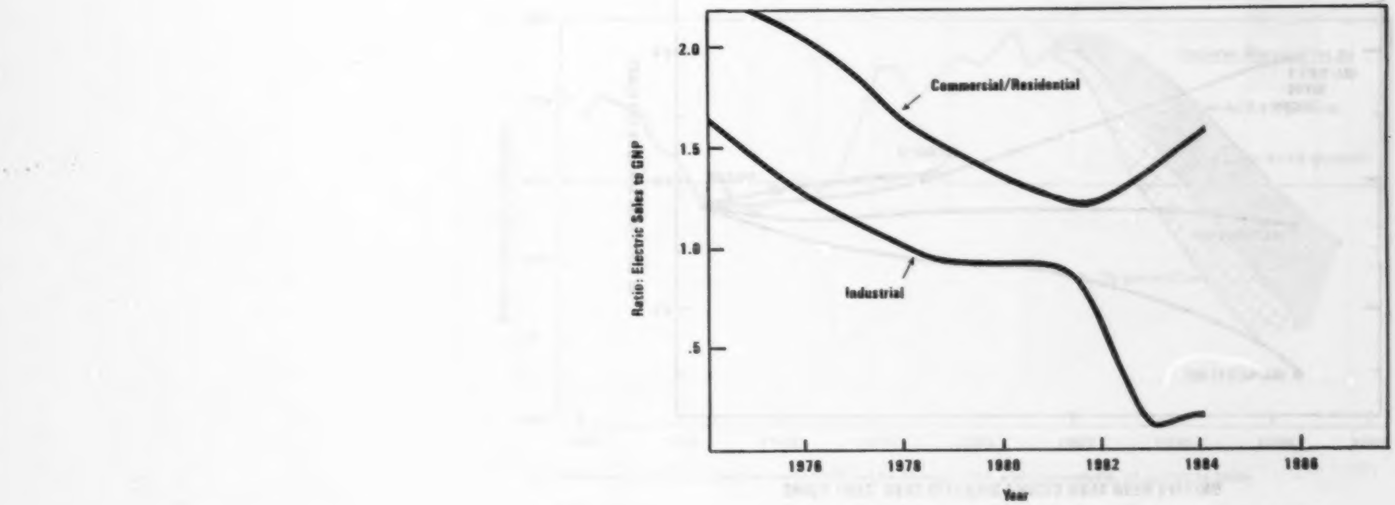
THE GROWTH IN ELECTRICITY OUTPUT AND GNP: A STRONG CORRELATION CONTINUES



*Projections based on current trends.

EXHIBIT 5

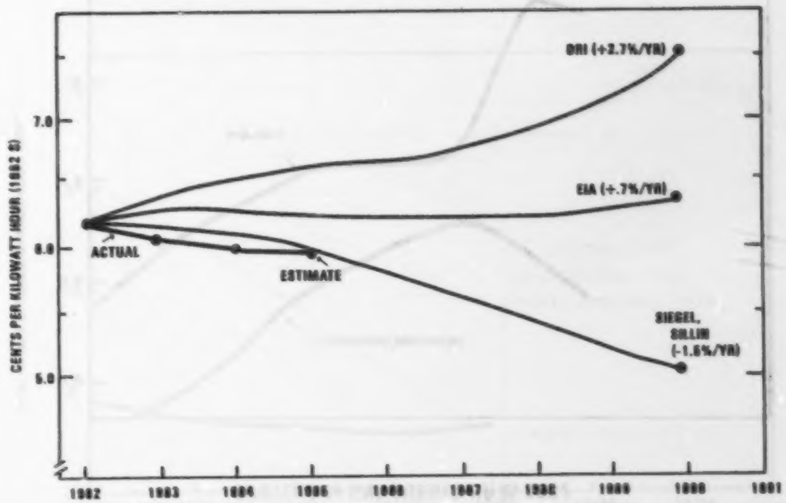
IN THE RESIDENTIAL AND COMMERCIAL SECTORS, THE ELECTRIC CONTENT OF GNP TURNED UP IN 1982



Note: Ratios are 5-year moving averages.

EXHIBIT 9

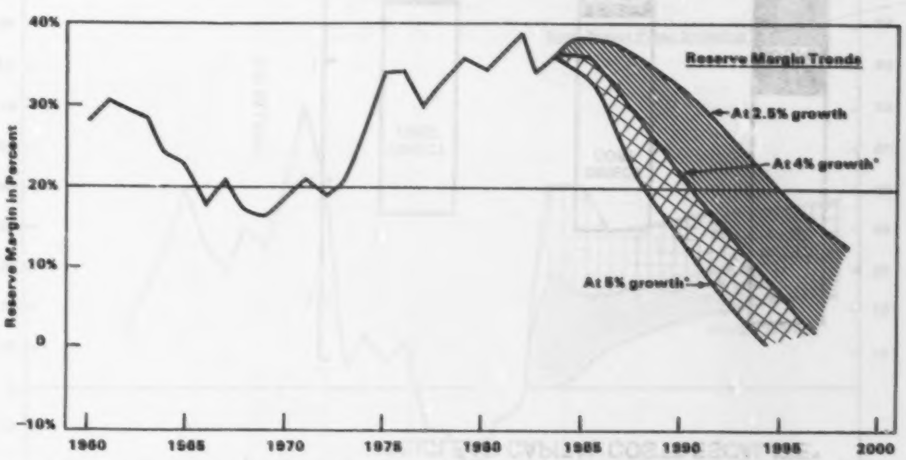
SINCE 1982, REAL ELECTRIC PRICES HAVE BEEN FALLING



SOURCES: J. SIEGEL AND J. SILLIN, "CHANGES IN THE REAL PRICE OF ELECTRICITY: IMPLICATIONS FOR HIGHER GROWTH", *PUBLIC UTILITIES FORTNIGHTLY*, SEPTEMBER 15, 1983. EIA (ENERGY INFORMATION AGENCY) AND DRI (DATA RESOURCES, INC.) PROJECTIONS, TAKEN FROM DOE'S JUNE 1983, *THE FUTURE OF ELECTRIC POWER IN AMERICA*.

EXHIBIT 10

WITH A 4 TO 5% GROWTH SCENARIO, RESERVE MARGINS FALL BELOW 20% BETWEEN 1988 AND 1990



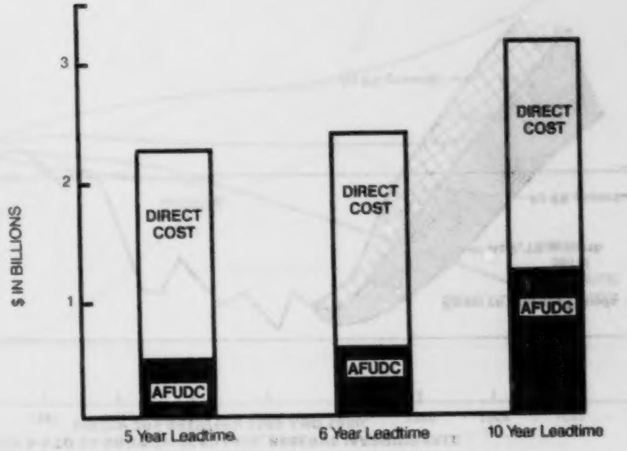
*Assumed: Peak load annual increase of 4% and 5% through 1990, and respectively, 3% and 4% to 2000.

NOTE: Historically, a national reserve margin of approximately 20% has been identified as that which is consistent with reliable electric service. For some regions a reserve margin as low as 15% and as high as 25% may be more appropriate, reflecting regional grid capabilities and peaking phenomena.

Source: Available Resources, 7/84 National Electric Reliability Council "Electric Power Supply and Demand"

EXHIBIT 11

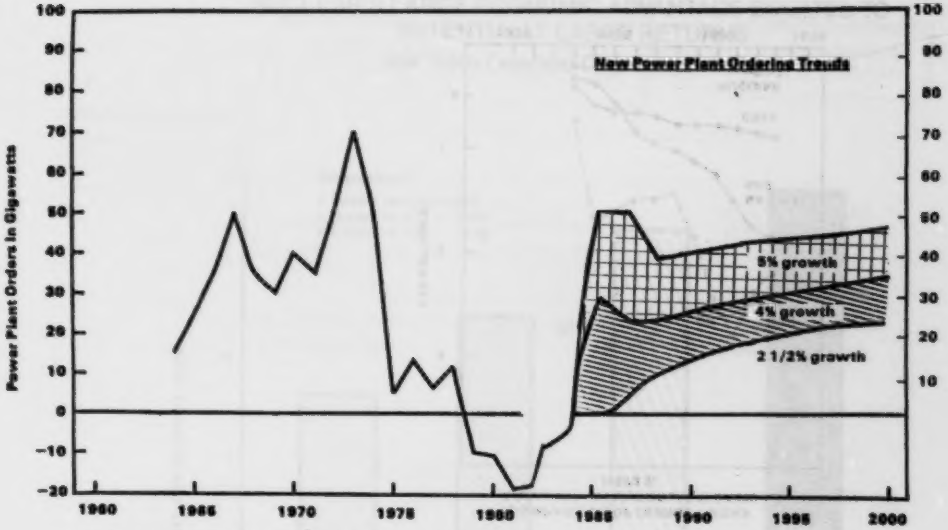
AS LEAD TIMES LENGTHEN, AFUDC MOUNTS AND NUCLEAR CAPITAL COSTS ESCALATE*



*Assumes 4% inflation and an AFUDC rate of 10 percent

EXHIBIT 11

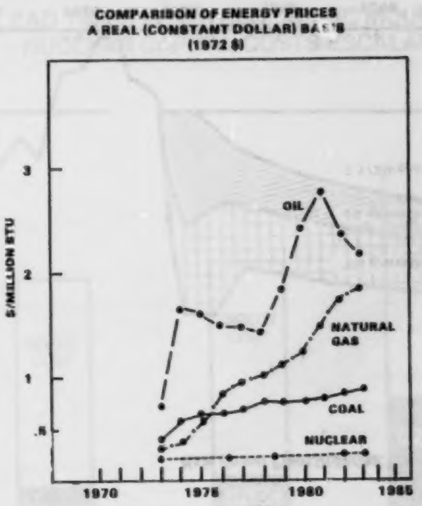
POWER PLANT ORDERING TRENDS AND PROJECTIONS*



*Projections of plant orders assume an 8 year licensing and construction lead time and maintenance of a 20% capacity reserve margin; growth is annual peak load increase; 4% assumed to decrease to 3% after 1990; 5% assumed to decrease to 4% after 1980.

EXHIBIT 13

ELECTRIC UTILITY FUEL CYCLE COSTS, PARTICULARLY COAL AND NUCLEAR SHOULD BE STABLE FOR THE BALANCE OF THE 1980s


COMPARISON OF ENERGY PRICES
A REAL (CONSTANT DOLLAR) BASIS
(1972 $)

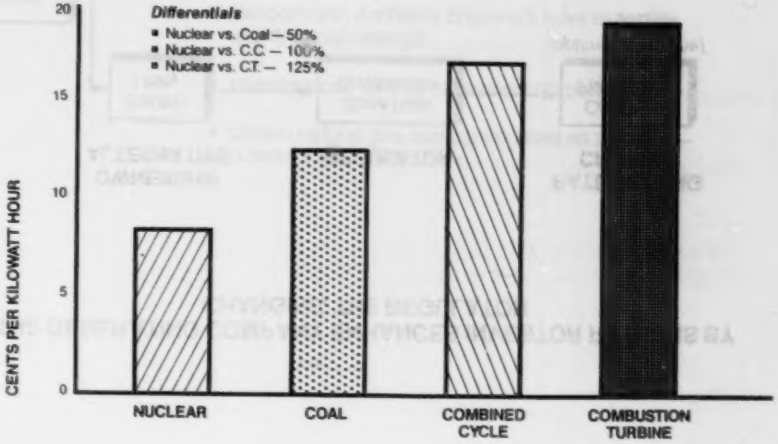
NATURAL GAS — AVERAGE PRICE OF GAS DELIVERED TO UTILITIES
OIL — AVERAGE PRICE OF RESIDUAL DELIVERED TO UTILITIES
COAL — AVERAGE PRICE OF FUEL DELIVERED TO UTILITIES
NUCLEAR — AVERAGE PRICE, NUCLEAR FUEL CYCLE

SOURCE: DOE, *MONTHLY ENERGY REVIEW;* ATOMIC INDUSTRIAL FORUM, INC.

EXHIBIT 14

NUCLEAR'S LARGE ECONOMIC ADVANTAGE EQUATES TO POTENTIALLY LARGE RETURNS

Mid 1990s Levelized Cost Comparisons



EXHIBIT

THE GENERATING COMPANY ENHANCES INVESTOR RETURNS BY CHANGING THE REGULATOR

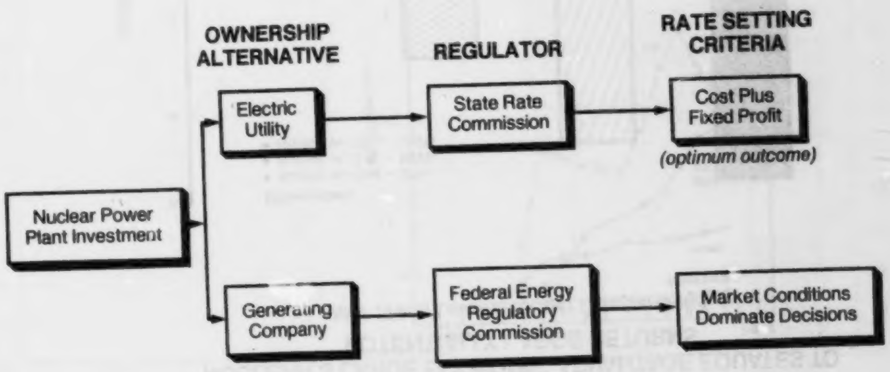

OWNERSHIP ALTERNATIVE
REGULATOR
RATE SETTING CRITERIA
Nuclear Power Plant Investment
Electric Utility
State Rate Commission
Cost Plus Fixed Profit
(optimum outcome)
Generating Company
Federal Energy Regulatory Commission
Market Conditions Dominate Decisions

EXHIBIT 16

ELECTRIC UTILITIES REPRESENT ONLY ONE GROUPING OF POTENTIAL GENERATING COMPANY PARTICIPANTS

- Electric Utilities are the obvious candidates
- Vendors and Architect Engineers have expertise and financial strength
- Investors can take direct ownership positions
- Oil and natural gas companies need an attractive outlet for their cash flows

EXHIBIT 17

OPPORTUNITIES WILL PROLIFERATE AS ELECTRIC LOAD GROWTH CONTINUES

- Buy-in opportunities exist at recently completed plants, and plants still under construction
- Cancelled or deferred plants can be resuscitated
- New plant construction can be initiated

Attachments

1. May 4, 1984 Wall Street Journal Article, "Dimming Our Electric Future".

2. April 28, 1985 New York Time Article, "The Impending Electricity Crisis". (Placed in the files of the Subcommittee.)

3. October 11, 1984 Public Utilities Fortnightly Article, "Managing to Reduce Nuclear Financial Risks".

reprinted from THE WALL STREET JOURNAL.
REPRODUCTIONS NOT PERMITTED
ISSUE OF MAY 4, 1984

Dimming Our Electric Future

By JOHN SIEGEL and JOHN SILLIN

Demand for electricity will grow 4% to 5% a year through this decade—nearly double current industry projections. The implications for our power supply are significant, with new plant and equipment commitments of at least $1.5 trillion required over the next 10 years.

This presents a paradox. While nuclear and coal plants are scrapped and the "green coalition" works to erect disincentives to central-station technology, we soon may be in dire need of more electricity, with no coherent strategy on how to get it. One thing is clear: Utilities don't buy this projection. Having been so badly burned financially in the past 10 years, they are no longer willing to "bet the company."

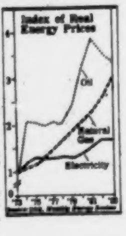
The real question for the future is what electricity policy we will be dependent on: cost-effective coal or nuclear technology, shorter lead time but higher operating cost combustion turbines, or price-induced conservation partly resulting from inadequate electricity supplies around 1990? Politicians and regulators hold the answers.

Increased electricity growth in the 1980s will occur for two reasons: improved economic growth above the 2.2% average of the past 10 years and market forces associated with electricity's dramatically improved price position relative to oil and natural gas.

The economy is in a fundamental transition, just as in 1973. This time, the transition is toward sustained economic growth in the 3.5% range, enhanced by coherent, long-range economic policies, stable or falling energy prices, and more moderate growth in the labor force. In short, a mirror image of the 1970s.

Nonlinear Relationship

Economic growth in the 3.5% range should work to strengthen the relationship between electricity demand and economic growth. Historically, this relationship has been nonlinear, trending upward during periods of sustained economic growth. Between 1960 and 1972, when annual gross national product growth averaged 4%, electricity growth was double that of GNP. Between 1973 and 1983, when GNP growth averaged 2.2%, electricity growth averaged 2.5%, or about 1.1 times GNP growth.



Reasons for the nonlinear relationship are clear. In periods of sustained economic growth, investment rates in new plant and equipment accelerate, resulting in a substitution of capital for labor, and increased energy usage. Further, in an improved economy, rising real income results in higher energy usage due to income elasticity effects.

From 1960 to 1972, for example, real personal income grew by more than 30%. Each percentage point rise in real income is estimated to result in a similar increase in electricity use; increasing real income contributed significantly to growth in electricity demand in the period. From 1973 to 1983, however, real income increased only 5%. In that period, the annual increase in capital spending averaged 1.1%, compared with an annual rate of 4.4% from 1960 to 1972. Further, a labor market expanding at nearly triple the 1960 to 1972 rate resulted in a substantial substitution of labor for capital—and thus less growth in energy usage. In the 1980s, more favorable financial markets, incentives to invest and a labor force growing at one-third the rate of the past 10 years should accelerate capital investment, productivity and real income growth—and electricity usage.

> *A possible shortage of electricity supply is closer than most imagine. With growth rates of 4% to 5%, demand will start to exhaust available supplies between 1988 and 1990. The implications are staggering.*

Electricity's greatly improved price position compared with oil and natural gas, and the likelihood that this will continue, is the second major reason electricity demand will top estimates.

Since 1973, electricity has improved its price position vis-a-vis oil and gas 150% (see chart). The resultant 22% gain in electricity use and 18% drop in gas and oil use enabled electricity to lift its domestic energy market share to 37% from 27%.

Before 1973, electricity's penetration rate in the new home heating market was 30% nationally. Following the 1973 run-up in oil prices, it jumped to 50%. Recently the rate hit nearly 70%.

And what about conservation, integral to soft energy's "least cost" energy strategy? Conservation has clearly taken place as a result of the overall run-up in energy prices. But relative price changes of the various energy forms have caused electricity consumption to increase, despite past stagnant economic conditions. Further, to a market economist, conservation is defined simply as a price-induced process whereby capital and labor are substituted for energy. If electricity prices are not rising, is conservation a viable strategy?

In fact, there will be downward pressure on electricity prices. The prospect of stable fuel prices, the fact that 80% of our electricity (compared with 65% in 1973) is now generated using coal, uranium and hydro (all relatively price stable in the 1970s), and a decrease in unit production costs as utility reserve margins decline will more than offset the upward pressure from relatively higher-cost plants entering service in the 1980s. Real electricity prices could decline as much as 15% late in the decade. In turn, this could accelerate demand and lower unit costs even further. Along this line, real electricity prices fell 2% in 1983.

In combination, sustained economic growth in the 3.5% range and the market impact of electricity's improved price position suggest that 4% to 5% electricity growth rates for the 1980s are likely. This growth began in 1983:

- Weather-corrected peak demand increased 4% in 1983. (Uncorrected for weather, peak load rose 7.6%.)
- Over the latest 52-week period, total electricity sales increased 7% from a year earlier.

So much for arguing that electric growth is distinct from GNP growth.

A possible shortage of electricity supply is closer than most imagine. With growth rates of 4% to 5%, demand will start to exhaust supplies between 1988 and 1990. The implications are staggering. Assuming a 10-year lead time for licensing and construction, no plant retirements, a 20% reserve margin, new plant commitments of 450 million to 700 million kilowatts—equaling investment of $1.5 trillion to $2 trillion—are necessary over the next 10 years. This compares with an effective ordering rate of zero for the past 10 years.

The immediate question is whether the electricity industry will continue to defer commitments to conventional technologies until reliability becomes an issue and the main recourse is to depend significantly on equipment with a short lead time but high operating costs. In that case, increasing electricity prices beginning around 1990 and questions of reliability could begin to limit electricity growth and hinder economic development, as well as increase oil and natural-gas consumption. Low growth projections could become self-fulfilling prophecies.

(over please)

To avoid this scenario, the current institutional environment—characterized by regulatory/political actions biased against adding new generating capacity—must undergo sharp change. Given the relative price stability of electricity over the past 10 years and the prognosis for more of the same, regulators should encourage the addition of new capacity to coincide with realistic estimates of growth. One must keep in mind that, typically, it takes a decade to plan, design, license and construct a single large electricity generating plant. Given this lead time, the 1990s—for utilities and rate regulators—are today.

Gambling With the Public Interest

But little is being done. For example, New Hampshire and Indiana have laws preventing the inclusion of Construction Work in Progress in the rate base—the one sound mechanism by which utilities can finance large new plants. Connecticut may soon follow. The result? New Hampshire and Indiana have two near-bankrupt utilities on their hands and billions in potentially wasted investment. But the states have no monopoly on myopia. After the Federal Energy Regulatory Commission ruled that utilities could earn a cash return on CWIP, the House passed a bill designed to overturn this decision. Senate action is due this month.

Politicians and regulators are gambling with the public interest: trading off short-term political expediency against a longer-term reliable and cost-effective supply of electricity. The stakes are high, as analyses show that the cost to consumers of having an insufficient supply of electricity greatly outweighs the cost of having too large a reserve margin. With excess capacity, both consumer and stockholder share the burden. With a shortage, only the consumer pays.

Next year—following three years of electricity growth in the 4% to 5% range—public-policy makers may finally recognize that a reliable and cost-effective supply of electricity is in jeopardy in the late 1990s, and that conservation doesn't work when electricity prices are falling. We hope that regulators would then encourage utilities to add reliable and cost-effective generating capacity. The ball is in their court.

Mr. Siegel is a manager with the Atomic Industrial Forum. Mr. Sillin is a consultant with Alexander Grant & Co. The views expressed are solely their own.

Managing to Reduce Nuclear Financial Risks

By JOHN O. SILLIN

Nuclear power plant projects have weathered volatile economic conditions and uncertain regulatory climates with varying degrees of success. Some electric utilities can point to excellent construction and operating records while others have suffered continuous difficulties. Are the success stories the result of good luck or effective management? This article identifies the potential sources of financial risk in a nuclear project and describes several methods available to management for controlling financial liability. A commitment to the highest level of technical and managerial skills is cited as a necessary component of all successful nuclear undertakings.

THE most significant issue now hanging over nuclear energy is the financial risk that both utilities and creditors associate with nuclear power plant ownership. For example, stories of originally estimated nuclear plant costs increasing by as much as tenfold, and then operating well below levels anticipated have caused obvious distress among utility executives, trustees, and shareholders. The financial community's nerves have been rubbed raw to the point that nuclear utilities have bond ratings below that of their nonnuclear brethren. In addition, the February, 1984, drop in the Dow Jones utility index was due almost wholly to nuclear issues surfacing at this time. Finally, the industry's shaken confidence is further underscored by the lack of any new nuclear orders since 1978, and the over 100,000 megawatts in cancellations since 1974.

But despite the general perception that all nuclear power plant projects result in catastrophic cost overruns, or that existing facilities have continuous operating difficulties, a number of utilities operate successful nuclear programs. These companies build nuclear plants for close to their originally estimated costs (at least on an inflation-adjusted basis), and operate existing facilities reliably, efficiently, and safely. For example, Duke Power Company, Florida Power and Light Company, and Arizona Public Service Company appear to have been successful in managing nuclear construction programs despite the existence of volatile economic conditions, and regulatory uncertainties with respect to the Nuclear Regulatory Commission and their respective state rate commissions. With respect to nuclear power plant operations, Wisconsin Public Service Corporation, Baltimore Gas and Electric Company, and Northeast Utilities, among others, have achieved outstanding records.

Thus, the issue of interest to the nuclear industry — and the public at large — is whether these and other companies owe their success merely to good luck, or whether they have actively managed their nuclear programs in such a way so as to reduce construction and operating uncertainties and resulting financial risks. The remainder of this article explores this use by:

- First, examining in more detail the individual components that have contributed to the financial risks associated with nuclear power;
- Second, describing options available to reduce the probability of events occurring that result in significant cost exposure;
- Third, measuring the benefits accruing to utilities that successfully deal with nuclear financial risk issues.

John O. Sillin is a manager with Alexander Grant & Company where his work has been focused in the areas of utility regulation, planning, and operations. Prior to joining Alexander Grant, he held positions at Booz, Allen & Hamilton Inc., the Power Authority of the State of New York, and Commonwealth Services, Inc. **Mr. Sillin** holds an MBA degree from New York University and a BA degree from Franklin and Marshall College.

Sources of Financial Risk

The financial risk associated with nuclear stems from the cost liability to which a utility is exposed, as compared to its ability to manage construction and operating activities safely and efficiently. It is the failure to manage or control these activities properly that determines whether financial liability of any significance will be incurred.

The four major areas from which cost liability may result are:

- Construction overruns;
- Equipment damage due to operating accidents or malfunctions;
- Large replacement power costs as a result of plant-in-service scheduling delays, or poor operating performance;
- Indirect or consequential damages resulting from a major operating incident, or long delays in putting the plant into service.

The Size and Source of Construction Cost Increases

The most obvious underlying cause of nuclear-related financial risks has been the startling growth in the cost of nuclear power plants. Since the early 1970s, the cost of nuclear facilities has increased nearly tenfold – going from under $150 per kilowatt to over $1,500 per kilowatt today. The reason for this cost increase began with the early 1970s escalation in the rates of inflation and interest. The effects of these higher rates on plant costs were compounded by lead times which lengthened from five to six years to ten to fifteen years. In addition, direct costs rose dramatically even on an inflation-adjusted basis because of increased labor, material, engineering, and equipment inputs. Over the last ten years these inputs have increased by a factor of two as a result of new safety, environmental, and other requirements related to licensing.

And as the cost of nuclear facilities has escalated, utilities have seen their financial risks increase. To begin with, shareholder capital is at risk for much longer periods of time than has historically been the case because utilities frequently earn little or no cash return on their investment during the six to twelve years it takes to build a nuclear plant. Combined with the facts that huge sums of money must now be invested to complete nuclear plants, and that obtaining rate adjustments allowing a profitable return on projects of this type are problematic at best, it is little wonder that the economic and financial attractiveness of building nuclear plants has deteriorated significantly.

Difficulties in the construction cycle further heighten these financial risks. The usual result is that regulators and politicians blame the utility for any cost overrun, with shareholders being forced to shoulder the overruns in the form of lost equity and reduced returns. To summarize, at issue is equity from both a customer and shareholder perspective.

But financial risks resulting from the longer-than-anticipated construction cycle, or increased investment requirements, are not always the fault of the utility. For example, the Nuclear Regulatory Commission, responding to the political and social controversy surrounding nuclear power in the wake of the Three Mile Island accident, has made decisions with respect to backfitting of equipment, plant redesign, and other related licensing issues. These decisions have frequently resulted in few benefits with respect to plant design, engineering, and overall integrity; lengthened the schedule and further complicated plant construction; and resulted in significantly higher costs to be paid by utilities, shareholders, and customers.

In addition, as rate commissions have generally followed a policy of rate suppression over the last ten to fifteen years, utilities have been unable to generate revenues which both cover cost increases and maintain financial health. As a result, nuclear construction projects were delayed, and plant costs increased sharply as the inflation, interest rate, and licensing effects identified earlier were extended.

On a more optimistic note, there are developments which will work to minimize future increases in plant costs, including

- Sharply reduced inflation;
- Improving financial markets;
- Increased load growth resulting in additional revenues and improved utility financial health. Increased load growth will also soon force efficiencies on the licensing process, thus reducing construction and planning lead times.

Nevertheless, the cost increases of the recent past have sharply increased utility financial exposure in the nuclear area.

The Potential Exposure from Damages to Equipment

The second major factor behind increased financial risk is that once a utility gets the plant up and running, any significant event adversely affecting operations can have severe economic costs. These costs again derive from the huge investment that utilities make in nuclear facilities. An event causing a lengthy downtime can result in a major percentage of a utility's asset base being unproductive. Obviously, either the ratepayer, the insurer, or the utility must pay for the facility whether it operates or not, as well as repair or replace damaged equipment. The Three Mile Island situation is the clearest example of the costs to be borne – over $1 billion for repair of unit 2 alone – and the financial risk that a utility is exposed to when something goes wrong.

Recent changes in the American Nuclear Insurers and Mutual Atomic Energy Liability Underwriters insurance pools now allow for coverage of primary property damage of approximately $900 million – as compared to $300 million when the TMI accident occurred. Nevertheless, the cost of nuclear facilities has escalated to the point where $900 million can equal less than half the value of a 1,000-megawatt unit. Thus, the utility owner, or ratepayer, is still left with a large potential exposure should a major mishap occur.

Potential Replacement Power Costs

The financial costs resulting from operating mishaps, or delays in bringing nuclear plants into service, are further magnified by the fact that nuclear generated electricity is typically the most economic source of power. On a variable cost basis nuclear facilities can have:

- One-half to one-quarter the fuel costs of coal plants depending on the source and type of coal utilized;

- One-fifth to one-tenth the fuel costs of oil-fired facilities depending on the type of fuel burned (distillate, resid, sulfur content of fuel), and the efficiency of the unit in which the fuel is burned.

Thus, replacing the annual output from a 1,000-megawatt nuclear facility with coal-fired capacity could result in added fuel expense of $100 to $200 million annually. Replacing the lost output with oil-fired generation could result in additional annual fuel costs of as much as $500 million.

Some replacement power cost insurance can be purchased from Nuclear Electric Insurance Limited (NEIL), thus reducing a utility's potential exposure and risk. NEIL was created in 1975, and issued its first policy in 1980. But coverage from this program is limited — payments begin only after a 26-week period and run for a maximum of two years. In a situation comparable to TMI this program would have covered only a fraction of replacement power costs. Because the policy deals only with damaged reactors, it appears that the cost of replacement power associated with the outage of TMI unit 1 would not be covered. Also, there is apparently no coverage for plants under construction which experience start-up delays well past their originally scheduled in-service date.

Thus, it becomes clear that the allocation of replacement power costs only heightens the controversy of who pays the additional expense, and bears the financial risk, if a nuclear power facility fails to operate as anticipated.

Indirect or Consequential Damages

In the event that a nuclear accident happens the costs incurred by the utility, insurer, or vendor will not necessarily be limited to equipment repairs and replacement power purchases. Extensive litigation may be brought by customers or by state and local officials to assess responsibility for injurious health effects or other consequential damages. But any accurate estimate of the costs that could be assessed is impossible to make in advance. Determining the dollar value of damages, as well as assigning responsibility, is complex and must be handled on a case-by-case basis.

A final complicating factor in allocating the financial costs associated with nuclear power plant incidents is determining who is responsible for the construction or operating error. Potential candidates typically include:

- The utility and its employees, always the most obvious target;
- The vendor for supplying faulty equipment;
- The architect-engineer or construction manager.

Controlling Construction Components Contributing To Nuclear Financial Risk

Over the past ten years, the building of major nuclear power facilities has obviously increased in complexity. For example, the average number of engineering man-hours required for the design and construction of a twin-unit nuclear facility has increased from 2.6 million in the early 1970s, to 7.3 million in the early 1980s. Craft man-hour requirements have shown a similar trend, increasing from 6.9 man-hours per kilowatt in the early 1970s, to 19.5 in the early 1980s. The actual quantities of materials required in the construction of nuclear facilities also have increased significantly. (Exhibit 1.)

The major reason for these increases in both labor and materials is the stringent safety and other licensing requirements that were promulgated beginning in the mid-1970s. These regulatory requirements typically took the form of seismic and missile protection, pipe break criteria, fire protection, plant security, physical separation, radwaste control, in-service inspection, and cooling towers and ponds.

But increased complexity does not necessarily mean inefficiency, or an inability to get the job done. Exhibit 2 presents various sustained installation rates for materi-

EXHIBIT 1

COMPARISON OF ACTUAL QUANTITIES FOR COMPLETED NUCLEAR PLANTS
VERSUS ESTIMATED QUANTITIES FOR COMPARABLE UPCOMING
SINGLE AND TWIN UNIT NUCLEAR PLANTS

	Actual or Estimated Quantities					
		Twin Unit			*Single Unit*	
Item (Unit)	*Plant A (Actual Data)*	*Plant B (Estimated)*	Δ *Per Cent*	*Plant C (Actual Data)*	*Plant D (Estimated)*	Δ *Per Cent*
Concrete (cu.yds.)	271,000	400,000	47.6	141,000	280,730	99.1
Rebar (tons)	17,900	24,850	48.6	10,000	NA	—
Steel (tons)	11,100	21,840	96.8	1,900	NA	—
Piping — LD (L-F)	252,000	363,000	44.0	105,000	292,908	179
Piping — SD (L-F)	242,000	262,600	8.5	92,000	180,417	96.1
Cable (L-F)	6,707,000	10,100,000	50.6	2,500,000	5,217,658	108.7
Conduit (L-F)	511,200	627,800	22.8	458,000	530,015	15.7
Cable tray (L-F)	79,000	119,000	50.6	NA	111,843	—
Termination (Ea)	244,000	267,000	9.4	102,000	234,000	129.4
Type of NSSS	BWR	BWR	—	BWR	BWR	—
Commercial Oper.	1974	1983-84		1974	1984	—

SOURCE: "Power Plant Scheduling, Construction and Costs: Ten-year Analysis," by Ramesh N. Budwani, *Power Engineering*, August, 1982.

Exhibit 2

Average, High, and Low Sustained Installation Rates for Nuclear Power Plants

Item	Unit	Sustained Installation Rates Per Month Low	Average	High
Concrete	Cu. Yds.	3,400	6,400	9,400
Rebar	Tons	400	550	720
Steel	Tons	160	340	410
Conduit	L-F	7,200	12,440	19,500
Cable tray	L-F	1,795	2,900	5,300
Cable	L-F	100,000	168,100	292,000
Termination	Ea	4,610	6,660	10,670
Piping – LD	L-F	2,640	3,900	6,160
Piping – SD	L-F	3,200	4,795	6,950

Source: "Power Plant Scheduling, Construction and Costs: Ten-year Analysis," by Ramesh N. Budwani, *Power Engineering*, August, 1982.

als required in the construction of nuclear power plants. The dramatic difference in these rates indicates that some plant construction labor forces are being managed with considerably greater efficiency than others. While no detailed analysis has yet been done on a plant-by-plant basis to establish the specific reasons for these disparities, the higher levels of productivity would appear to be a function of:

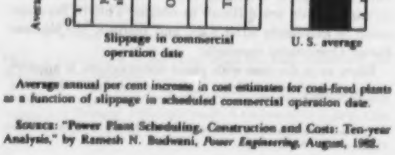
- *Design criteria*, including ensuring that all design and engineering work is performed on schedule, and that the plans have been inspected and approved to ensure plant integrity and accessibility of equipment and plant systems. In addition, having design and engineering work done well in advance of actual construction allows for better planning and increased efficiency.
- *Equipment and material deliveries*. This includes making sure that critical path items are delivered on time and are of the quality and specifications contracted for.
- *Plant management*, including determining the manpower and skill levels required during each phase of plant construction, and ensuring that craft construction personnel are properly supervised. In addition, after the installation of major equipment items or plant systems, tests and surveillances need to be conducted, monitored, and carefully controlled to ensure they meet design and licensing requirement standards, and that dependent systems can subsequently be installed and tested.
- *Quality control*, including anticipating and promptly responding to NRC inspection and licensing requirements, and cooperating with and being responsive to internal quality assurance and quality control programs. In all likelihood the tougher the internal program, the smaller the probability of external NRC licensing problems, and the greater the likelihood that the project will proceed on schedule.
- *Licensing*. An aggressive approach to keeping the NRC informed in all areas related to plant construction should be taken. This includes the utility staying on top of the NRC (instead of the other way around) regarding the permitting process, and keeping the licensers "on track and on schedule." This approach also requires the owner to make sure the licensers understand all information submitted, and that they agree with the utility regarding its adequacy. Florida Power and Light's experience with the St. Lucie project is probably the best example that can be offered in this regard.

Finally, and perhaps most importantly, *project management authority should be centralized*. This results in a consistency and a greater degree of coordination and control in overall project direction than might otherwise be the case. This management authority should reside in the owner – assuming qualified personnel have been retained – since the owner has the most at stake.

Thus, with the exception of weather and other acts of God, it is management's determination to control the factors cited above that has much to do with whether a plant meets is originally scheduled fuel load date.

The average slippage for nuclear plants presently under construction is roughly four years, but there is a wide variance around this average. Exhibit 3 presents the average annual per cent increase in cost estimates for coal-fired plants as a function of slippage in scheduled commercial operation. Because construction of both coal and nuclear plants is a large undertaking requiring long lead times and huge commitments of capital, there is no reason to believe that the same basic pattern does not exist for nuclear plants. And, as can be seen from the exhibit, the longer the delay the more rapid the escalation in costs. In summary, the ability to manage large construction projects is a significant factor in plant construction scheduling, and affects the degree to which a utility is subject to cost overruns and financial exposure.

Exhibit 3



Average annual per cent increase in cost estimates for coal-fired plants as a function of slippage in scheduled commercial operation date.

Source: "Power Plant Scheduling, Construction and Costs: Ten-year Analysis," by Ramesh N. Budwani, *Power Engineering*, August, 1982.

Financial constraint — the inability to sustain construction expenditures at required levels — also is cited as a reason for lengthy plant building schedules. In this regard regulatory commissions — through the rate-setting process — have the most control over the financial resources a utility can avail itself to. Frequently, a utility has little or no control over this process, but is instead at the mercy of the regulators and local politicians. Nevertheless, there are activities within management's control to expand or husband financial resources. They include:

- Assuring that construction dollars are spent as wisely and efficiently as possible through the use of tight contracting policies, and other management activities identified above.
- Closely controlling operating expenses and other non-nuclear construction costs.
- Using public relations activities to get the message across regarding the enormity of the costs that result from rate regulatory-induced construction delays.

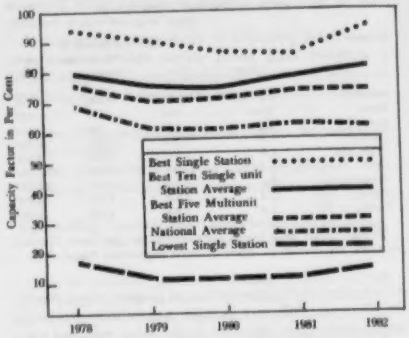
Controlling Operating Components Contributing To Nuclear Financial Risk

In addition to disparities in utility construction management, there appear to be significant differences in how utilities manage the operation of nuclear facilities, resulting in wide variances in operating results. For example, capacity factors for U. S. nuclear plants in 1982 ranged all the way from 13.5 per cent to 94.8 per cent; 57.5 per cent was average.

Completely unanticipated equipment failures and other related developments frequently explain a nuclear plant's poor operating performance for any given year. But certain plants appear to have a consistently better operating record than the national average. For example, a recent article in *Nuclear News** identified the top ten single nuclear units, and the top five multiunit stations, based on their operating performance for the past three years. (Exhibit 4.) By extending the analysis back two years, the results are not significantly changed, indicating that whatever the managers of these plants are doing, they are doing it consistently well.

Technical complexity is frequently offered as a rationale to explain these operating variances. For example, many of these top performers are older units; thus, the technical complexities associated with operating them are somewhat less than those of large new units coming on line today. But there are older nuclear units that have had operating problems. Also, because the older units were constructed when there were fewer requirements, certain records are difficult to obtain. This in turn can result in extremely strict NRC and Institute for Nuclear Power Operations oversight.

EXHIBIT 4
NUCLEAR POWER PLANT CAPACITY FACTOR COMPARISONS



Thus, as is the case with plant construction, it appears that management policies and practices have the most significant impact on nuclear station operating performance. Among management factors which determine how well a station will operate are detailed attention to each plant system, equipment and instrument, and development of in-depth familiarity with how they are affected by different maintenance practices and how they will perform under alternative operating modes.

Knowledge regarding the behavior of plant systems and equipment is in turn directly related to employee development programs. Included within this area are training programs, supporting educational programs, and employee incentives. Each of these programs has several objectives. They include to:

- Make all station employees expert in their individual fields of responsibility. Employees covered would include all maintenance, engineering, other technical service as well as operating personnel. Also, employees would not simply be "licensed," or "qualified" for the job, but the intent is to make them the "best at what they do."
- Educate employees with respect to overall nuclear power plant activities. Areas of education include chemical, mechanical, and electrical engineering, nuclear and health physics, and power generation. The purpose is twofold with each area directly related to the other: each employee understands how his job on any specific activity affects overall plant operations; employees who more completely understand their jobs are more likely to perform specific commands correctly, and not perform those commands or procedures which are in error.
- Encourage employees to want to do the best job possible. This is done by rewarding via compensation and promotion those employees who perform at outstanding or exceptional levels. Also, employees should be made aware of the potential impact on plant operations, customer costs, and company financial performance of a job performed well ver-

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*"Plant Factor Leaders Tell How They Do It," by E. Michael Blake, *Nuclear News*, March, 1983.

sus incorrectly, thus the employee has a greater appreciation for the significance of his job and the need to perform at the most exacting standards.

A third area that clearly affects performance is the quality and character of the managers in charge of running the plant. Superior plant managers:

- Are dedicated to doing the best job possible;
- Are aware and respectful of the complexity of the technology they are responsible for operating;
- Have strong interpersonal and human relations skills, and are able to give direction and counsel to employees;
- Hold those working at the station accountable for their actions, require superior performance from both themselves and others, and are themselves willing to be held accountable for their actions.

Common Characteristics of Successful Nuclear Utilities

While all nuclear utilities undoubtedly have programs to build skills in these areas, what sets apart those companies with outstanding records is their dedication to developing, implementing, and managing all nuclear activities to the most exacting standards for however long those plants are under construction and in operation. In general, those companies with good or outstanding performance in the nuclear construction and operation area appear to exhibit similar characteristics, including:

- Recognition that nuclear is a different technology than that which the industry has dealt with in the past. The nuclear technology is more complex than any other system utilities have built or operated, attendant with great risks as well as great potential benefits.
- A separation of the nuclear organization from other company functions. This is consistent with a recognition of nuclear's complexity, thus requiring a different set of technical and managerial skills than utilities have traditionally had to use.
- Recognition that if nuclear plants are to be built and operated successfully, only performance at the highest standards of excellence is acceptable. A clear commitment by senior management to make this happen is reflected in company hiring, employee development, promotion and compensation policies, and eventually is reflected in nuclear station operating and regulatory compliance performance. In addition, there is a recognition that the skills required to build a nuclear plant successfully are not necessarily the same as those required to operate it effectively. Finally, there is never a time when complacency can be tolerated; nor can it be assumed that the job of running the plant is ever at an end.

Reducing Financial Risk through Successful Construction and Operations Management

The wide variations in construction costs for nuclear power plants is illustrated in Exhibit 5. Even facilities that have in-service dates in close proximity to one another show wide cost differences. Utilities owning facilities whose price tags put them on the lower or middle range of the cost variation clearly will have a significantly smaller financial exposure than those utilities building higher-cost plants. And, as can be seen from the exhibit, differences of $500 to $1,000 per kilowatt ($500 million to $1 billion for a 1,000-megawatt plant) are not unusual for plants scheduled to go into service in the same year.

With respect to nuclear plant operations the potential for reduced financial exposure is nearly as large as in construction. For example, the difference in annual fuel cost savings between a 1,000-megawatt nuclear unit running at a 70 per cent capacity factor (slightly below the average of the best nuclear units identified in Exhibit 4) and the 57.5 per cent national average is approximately:

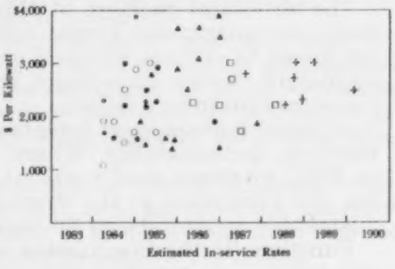
- $50 million assuming replacement energy from oil capacity;
- $20 million assuming replacement energy from coal capacity.

Finally, the safe and efficient operation of a $1.5 billion nuclear facility (one million-kilowatt plant costing $1,500 per kilowatt) increases the likelihood that the utility will be earning a reasonable return on its investment in the plant.

In addition, the cognizant rate commission is more likely to look favorably on utility earnings requests because of fuel and other cost savings resulting from

Exhibit 5

Estimated Nuclear Construction Costs



Key:
○ 95% or More Complete
● 90%-95% Complete
• 80%-90% Complete
▲ 50%-80% Complete
□ 40%-50% Complete
+ Around 20% Complete

Plants in Operation or Whose Construction Has Been Indefinitely Deferred Are Not Included.

Source: *Energy Digest*, November, 1975, pp. 250, 251. Electric Power Supply and Demand, 1983-1992, North American Electric Reliability Council, July, 1983.

efficient nuclear plant operations. In fact, one incentive policy that commissions might want to consider is allowing the utility and its shareholders to retain a portion of the economic benefits which result from improved nuclear power plant performance. *This performance should be measured in terms of both operations and safety.*

Summary

Clearly, the most important conclusion which the reader can draw from this article is that nuclear financial risks can be controlled and reduced through utility management actions. These include:

- Controlling costs and keeping plant construction on schedule through the tight management of contracts and maintaining high levels of productivity through strict attention to design criteria, equipment deliveries, construction management, quality control, and licensing;
- Ensuring the most exacting levels of plant operating performance by paying strict attention to equipment and plant systems, putting in place appropriate employee development programs, and recruiting, promoting, or keeping in place mangers of the highest caliber.

Such policies can enable utilities to realize that many aspects of nuclear construction and operation at one time assumed to be uncontrollable, are in reality subject to management control. And when combined with a rapidly improving economic environment and increased load growth, the attractiveness of the nuclear option may not be nearly as bleak as presently perceived.

To summarize, a successful nuclear program which significantly reduces potential financial exposure and increases economic benefits requires utility managers to manage at the highest standards of excellence.

STATEMENT OF MARCUS A. ROWDEN

Mr. Rowden. Thank you, Mr. Chairman. My testimony speaks to a nuclear regulatory program in disorder. It draws on my views from the vantage point of the private sector over the past 8 years, and on the experience of the 15 or so years I spent as a nuclear regulator, first with the Atomic Energy Commission, and then on the Nuclear Regulatory Commission.

I see fundamental defects in this country's nuclear regulatory program. A flawed NRC structure, an archaic licensing process, and an industry-NRC interface which is badly skewed.

The structural problem at NRC is the five-member commission itself. A management format inherited from the AEC with what I am forced to say was minimal congressional consideration as to its regulatory fitness. Experience over the past 10 years has proved this structure to be a failure.

Collegial management defeats a requisite of sound public administration, accountability. Where collective management reigns, as at NRC, no single public official, be it the individual Commissioners, the Chairman, or the President himself can be fixed with unmistakable accountability for regulatory performance.

Functionally the Commission structure at NRC has led to excessive reliance on case-by-case treatment of regulatory issues, to judicialization—even overjudicialization—of the nuclear regulatory program, and to policymaking falling by default to regulatory staff action or inaction, and to ad hoc decisions by the licensing boards.

The NRC Chairman and a majority of the Commissioners have themselves told the Congress that this structure simply does not work.

Regrettably, President Carter did not adopt the advice of his post-TMI blue-ribbon panel to replace the Commission with a single administrator, the organizational format which Congress itself has legislated for every other major Federal safety program. That change is long overdue at NRC and merits renewed congressional attention.

The second group of problems relates to the process by which nuclear powerplants are licensed. The current two-step process allows construction to proceed on the basis of preliminary designs, permits deferral of important safety decisions until after a plant is built, and frustrates meaningful public participation. This process defies not only sound regulation but common sense as well.

The solution, I believe, lies in the licensing reforms proposed in three bills now pending before the subcommittee, H.R. 1029, H.R. 1447, and H.R. 2488. These bills reflect the broad reform consensus built on the integrated concepts of design standardization, early site approvals, a single stage of licensing, and the assurance of stability for regulatory approvals once given.

Process reform is a matter within this subcommittee's jurisdiction, and I urge its priority treatment.

The third problem area I see is the faulty interface between the industry and its regulators in assuring nuclear plant safety. By law, the NRC oversees the safety of licensed nuclear activities. In operational reality, however, it is the utility licensees who have hands-on responsibility for their plants and no amount of regulatory oversight, whatever its vigor, is going to alter that fact.

NRC's approach to regulation blurs that fact. Nuclear regulation in the United States embodies an extraordinary degree of agency paternalism, creating relationships between regulators and regulated which are far different than those found in more successful nuclear power programs abroad.

This is simply nonsensical from a safety standpoint since the result stifles industry self-reliance and industry safety initiative. The major post-TMI inquiries, the Kemeny Commission and the Rogovin reports were severely critical of this regulatory cast of mind and of the industry attitudes it produced.

If industry self-reliance is a desirable public goal, as I believe it to be, NRC policy should place greater emphasis on performance objectives, rather than prescriptive requirements. As to the related goal of industry initiative, this will be furthered by practical regulatory incentives—assurance that what industry itself does effectively, NRC will not duplicate.

Beyond that, good performers should be treated differently than deficient ones, rather than regulating, as is too often the case now, for the lowest common denominator of licensee capability. I do not see this as self-regulation, but rather as sensible regulation.

Finally, I think we need to draw the distinction between an arms-length industry-NRC relationship, which most of us would accept as desirable, and the adversarial role-playing which now prevails.

Mr. Chairman, while I have canvassed a host of regulatory problems, corrective actions simply cannot await the ability to cure them all at once. We have a fair consensus on the needed elements of licensing reform, and I would urge the subcommittee to address that matter as its first priority.

Reform legislation is not going to solve all the problems facing this country's nuclear power program, many of which, of course, lie outside the regulatory sphere. But that is no reason for delaying action on a problem for which the Congress itself bears a special responsibility.

Changing a counterproductive licensing process is not simply nuclear regulatory reform, it is both sensible energy policy and good Government as well.

Thank you, Mr. Chairman, for the opportunity to contribute my views.

Mr. BRYANT. Thank you, Mr. Rowden. I enjoyed sharing the podium with you.

[Statement of Mr. Rowden follows:]

PREPARED STATEMENT OF MARCUS A. ROWDEN

SUMMARY

A primary problem affecting the use of commercial nuclear power in the U.S. is the federal regulatory system.

The five-member Commission structure has proved unworkable. It defeats accountability for regulatory performance; it has led to excessive reliance on case-by-case analysis and to overjudicialization; and it frustrates effective management of the agency's staff and regulatory programs. The Commission should be abolished and replaced by a single administrator.

The current licensing process is unstable in its requirements, unpredictable in its application, and it provides for public participation at a time and in a manner which ill serves public, industry and regulatory needs. This process should be reformed by enactment of the proposals embodied in H.R. 1029, H.R. 1447, and H.R. 2488. NRC should be authorized to approve standardized designs and sites independent of license applications, to issue combined construction and operating licenses in a single proceeding, and to modify these regulatory approvals only after systematic analysis of the need for and effects of a change.

NRC's approach to regulation embodies an extraordinary degree of regulatory paternalism and adversarial role playing. The safety price for this is the discouragement of industry initiative and inhibitions on industry-regulatory cooperation. NRC should encourage licensee responsibility by placing greater emphasis on performance objectives rather than prescriptive detail and by providing regulatory incentives for self-initiated industry evaluation and improvement. Relatedly, NRC should eschew regulation geared to the lowest common denominator of industry performance.

Although remedial action is called for on multiple fronts, Congress should address licensing reform as a first priority.

Mr. Chairman and Members of the Subcommittee:

My name is Marcus A. Rowden. I am a partner in the law firm of Fried, Frank, Harris, Shriver & Jacobson, resident in the firm's Washington office. My practice specializes in nuclear energy and other high technology matters, both within the U.S. and internationally.

Between 1962 and 1975, I served sequentially as Assistant General Counsel, Solicitor, Associate General Counsel, and General Counsel of the Atomic Energy Commission. Between January 1975 and June 1977, I served as one of the first five Commissioners of the newly established Nuclear Regulatory Commission, and between April 1976 and the expiration of my term on June 30, 1977, I was the Commission's Chairman.

Although I have been retained to advise the General Electric Company on nuclear regulatory issues -- particularly, nuclear licensing reform -- and I have been active in various industry groups examining nuclear regulation, the views I express today are my own. They are the views of someone who, for 15 years, served as one of the principal nuclear regulators and who is seriously concerned about fundamental flaws in our present nuclear regulatory processes and about their adverse effects on the soundness of the U.S. nuclear power program and on the public which it serves.

In your letter of invitation, Mr. Chairman, you asked me to comment on the problems facing the nuclear industry in this country and to recommend possible solutions to those problems. In my judgment, a primary problem facing the use of commercial nuclear power in the U.S. is the federal regulatory system. This problem area has three basic subsets: (1) structural problems with the Nuclear Regulatory Commission; (2) problems inherent in today's licensing process; and (3) what I call "interface" problems, by which I mean problems resulting from the way in which the NRC relates to the industry it regulates.

Structural Problems

The NRC's principal structural problem is the five-member Commission itself. In a real sense, this collegial form of regulatory program management is an experiment that failed. The NRC inherited its commission structure, with minimal Congressional consideration as to its regulatory fitness, from the former Atomic Energy Commission. Paradoxically, the AEC was structured as a collegial body because of its defense program responsibilities -- not its regulatory or other civil nuclear programs -- and, in fact, the AEC's regulatory program was managed by a senior staff officer with minimal Commission involvement. More instructively, perhaps, every other major Federal safety program is headed by a single administrator (as witness the Federal Aviation Administration, the Food and Drug Administration and the Environmental Protection Agency); it has been economic regulation which Congress has wisely vested in collegial bodies.

The Commission structure for nuclear regulation has, in practical operation, proved unworkable; and, in my judgement, it constitutes one of the primary causes of the progressively deteriorating nuclear licensing and regulatory processes. As I see it, there are at least four major problems with the agency's present structure:

First, the commission structure defeats a requisite of sound public administration -- indeed, of representative government -- that of clear authority and accountability for agency performance. Where everyone is in charge, nobody is; and where collegial management reigns, such as at the NRC, no single public official (be it the Commission members, the Chairman or the President himself) can be fixed with clear accountability. In my view, there is no more sobering or salutory principle of sound government than that of accountability. When programs or policies fail or agency management is ineffective or inefficient, the Congress and the public should know clearly who is to be held to account.

Second, the commission structure of NRC has led to excessive reliance on case-by-case treatment of regulatory issues and to overjudicialization -- both of the licensing process and of the nuclear regulatory program itself. Confronted by the institutional obstacles posed by collegiality, the Commission has largely abdicated its policymaking responsibilities to incremental action (or inaction) by the regulatory staff and to ad hoc decisionmaking by its licensing boards. Moreover, the Commission has tended to view itself -- or to find itself cast -- as a panel of judges emphasizing procedural niceties rather than setting broad policy. The failings of collegial management will be exacerbated, I believe, as the NRC completes the licensing of the present generation of reactors and becomes primarily a regulatory program manager rather than a facility licensor.

Third, the present NRC structure undermines effective policy leadership. The groping and ineffective Commission efforts to achieve meaningful administrative reform of the regulatory process are clear evidence of this problem. Another notable example is the Commission's failure to move more effectively to facilitate design standardization -- despite the NRC's professed convictions as to standardization's safety and other regulatory benefits, and despite the proddings of the Congress, the industry, and the post-TMI studies.

Fourth, the commission structure impedes effective management of the NRC staff and, in consequence, the agency's regulatory programs. One of the principal findings of both the Presidental and the NRC post-TMI studies was that, as a result of its collegial management, the NRC was (in the words of the NRC-sponsored study) "an organization that is not so much badly managed as it is not managed at all." The managerial inefficiency of the NRC, those studies concluded, is directly attributable to the diffusion of authority among the five Commissioners. While modest increases were made in the managerial authority of the NRC Chairman and of the Executive Director for Operations by Reorganization Plan No. 1 of 1980, neither official possesses adequate authority to effectively manage the NRC's administrative functions.

The commission structure of NRC was flawed from the outset. Only seven months after the agency was established, Congress found it desirable to supplement the inadequate managerial powers of the Chairman; however, the new authority was never really implemented because of collegial sensitivities to a dimunition of collective Commission authority. The Carter Administration also tried to prop up the commission structure at NRC, without altering it, through Reorganization Plan No. 1 of 1980. Ignoring the advice of the President's and the NRC's post-TMI blue-ribbon panels, which recommended that the Commission be replaced by a single administrator, only patchwork changes were made by the 1980 Plan. These changes, it is plain, have failed to cure the Commission's fundamental structural flaws. At Congressional hearings in February 1984, and again in March 1985, a majority of the NRC Commissioners openly expressed their dissatisfaction with the Commission's ability to fulfill its mandate.

In my judgment, the time has come -- indeed, is long overdue -- to abolish the Commission and replace it with a single administrator. Doing so would fuse authority and responsibility for nuclear regulation in one individual. It would improve management of the agency, facilitate policy making, and ensure accountability. And if these improvements can be realized, the cause of nuclear safety will necessarily be advanced. The single administrator proposal, in my opinion, is supported by compelling arguments; it deserves this Subcommittee's careful consideration.

The Outmoded Licensing Process

The second group of problems I wish to address result from the process by which we license nuclear power plants in this country. That process is unstable in its requirements, unpredictable in its application, and it provides for public participation at a time and in a manner which ill serves public, industry, or regulatory needs.

Congress has never taken the time to match the licensing provisions of the Atomic Energy Act to the demands of a developed and commercially deployed nuclear technology. In establishing the current two-step licensing process in 1954, Congress applied to nuclear power plants the same procedures used to license television and radio stations and promised to revisit the issue in a few years. While certain legislative changes were made in the late 1950's and early 1960's, essentially the same "stopgap" licensing procedures have remained in place for over thirty years. The regulated technology and the public's needs, on the other hand, have altered dramatically during this period.

The current two-step licensing approach -- often referred to as the "design-as-you-go" approach -- is an unacceptable way to license nuclear power plants. It encourages use of custom, one-of-a-kind designs, which squanders limited technical and safety resources and frustrates resolution of generic issues. It permits the NRC to authorize facility construction on the basis of preliminary designs and to defer final design review until after the plant is built, resulting in utilities investing billions of dollars in plants with no assurance that costly design changes will not be ordered or even that the plants will be allowed to operate. And, this two-step licensing process frustrates public participation. Although the current approach purports to offer two opportunities for a public hearing on each plant, one occurs at a time when only a fraction of the design information is available and the other comes after the plant is built. Thus, one opportunity comes too early and the other too late to be meaningful or effective.

The solution to these problems lies in licensing reforms embodied in three bills now pending before the Subcommittee -- H.R. 1029, H.R. 1447, and H.R. 2488. Each of these three bills has as its keystone design standardization -- and rightly so. Standardization offers the single most important contribution not only to a timelier and far less costly nuclear power plant completion cycle, but also to a more effective licensing and regulatory process and to the assurance of a high level of safety. But more is required than simply authorizing the Commission to approve standardized designs. If standardization is to succeed, it must be an integral part of an overall licensing process which is shaped to encourage its use and to realize its benefits. Thus, standardization legislation should also authorize the Commission to issue combined construction and operating licenses, to approve sites prior to the filing of license applications, and to provide stability to regulatory approvals once given. Each of the three bills pending before you would do all of these things.

Taken together, standardization, early site approvals, single stage licensing, and the assurance of regulatory stability would vastly improve the nuclear licensing process. These reforms would markedly enhance predictability. Since designs would be preapproved by the NRC in generic proceedings -- following thorough regulatory review and an opportunity for public hearing on safety issues -- a utility would know that a design it proposes to use is acceptable before it starts building the plant. Utility executives would better be able to estimate how long the plant will take to build and how much it will cost. And plants will take less time to build and cost less because they will be built according to standard, approved designs rather than designed as they are being built. Standardization has proved itself in nuclear programs elsewhere in the world -- most notably France -- and we ought to profit from that experience.

These reforms, moreover, will improve NRC regulation by focusing NRC review on a few standard designs, and by doing so far earlier than at present -- at the design stage, rather than after the plant has been built. Similarly, they will facilitate public participation by providing a hearing opportunity on each design, site, and combined construction and operating license before a utility has invested substantial resources in building a plant -- hearings that will be more meaningful than at present since they will be supported by essentially complete design information. And, of paramount importance, these reforms will increase safety and quality assurance.

At this point in my testimony, Mr. Chairman, I would like to compliment the initiative taken by members of this Subcommittee on behalf of constructive nuclear licensing reform. As I know from personal involvement while in public office, licensing reform legislation has been proposed repeatedly since 1971 -- by the AEC, the NRC, the Carter Administration, and now the Reagan Administration. In the past, these process reform measures -- while ostensibly centered on design standardization and one step licensing -- have been weighted down with a baggage of peripherally related proposals which have generated sufficient controversy as to make them politically unacceptable. That was the case with the two proposals submitted by the NRC and DOE two years ago.

Last year, members of this Subcommittee took the lead in drafting what I believe to be a reasonable, workable compromise between the extremes represented by the old DOE and NRC bills -- a measure which eliminated the less central issues addressed by those two bills. The reasonableness and quality of that compromise bill -- reintroduced earlier this year as H.R. 1029 and drawing bipartisan political sponsorship -- was confirmed later in the year when both the NRC and the DOE revised their bills to adopt positions close to those staked out by H.R. 1029 on all major issues.

As a result, there now appears to be remarkable consensus on the major issues. Indeed, as I understand previous statements of the Union of Concerned Scientists, that organization also finds merit in design standardization; and it does not object to single-stage licensing and early site approvals, per se. UCS objects primarily to the possibility that the proposed legislation would (1) hamper the NRC's ability to compel necessary design changes -- that is, its ability to impose "backfits" -- and (2) restrict the public's right to a hearing on construction issues at the preoperational stage. Although these are legitimate concerns, I believe that the pending licensing reform bills deal with them responsibly.

Backfitting. There is little question in my own mind, that backfitting -- the process by which the NRC requires a licensee to make changes in the design, construction, or operation of a nuclear power plant -- is one of the principal problems afflicting plants now under construction or in operation. Backfitting as practiced by the NRC has resulted in substantial disruption, delay, and expense -- and, worst of all, has produced a disorderly and often counterproductive approach to assuring facility safety. In 1982, the Grace Commission estimated that backfits imposed by the NRC on the 37 nuclear power plants licensed during the 1970's had cost their utilities and ratepayers over $2.1 billion. Backfitting on this scale and the manner of backfit imposition has generated even NRC concern as to the possible adverse impact on the safety of nuclear power plants. In 1981, in the wake of mandated post-TMI backfits, senior NRC staff officials reported that "the pace and nature of regulatory actions have created a potential safety problem of unknown dimensions."

Despite these problems, no one would seriously suggest prohibiting the NRC from requiring licensees to take actions determined necessary to ensure the safe operation of their facilities. Neither the pending rulemaking changes to the NRC backfit regulation nor any of the stability provisions in the aforementioned standardization bills would have that effect. To the contrary, the proposed NRC rule and the three bills are designed to require the NRC to systematically analyze the safety implications of any regulatory change before imposing it. They would not impair the NRC's ability to direct a necessary change if required to assure safety; they would require NRC decisionmakers to provide a focused administrative and decisionmaking process for backfitting and to establish clear criteria and standards for backfit imposition.

Backfitting should not be "closet" process -- devoid of clearly established and publicly understood decisional principles. The public as well as the industry deserves a backfit process which rests on openly declared decisional criteria and which considers both the safety benefits and the impacts of proposed backfits before imposing them.

Hearings. I also disagree with the UCS on the issue of preoperational hearings. All of the proposed bills would provide an opportunity for a public hearing on a sensibly limited range of issues at the preoperational stage. Specifically, all three bills would guarantee the public an opportunity for a hearing on issues that were not and could not have been raised and resolved in the combined construction and operating license, the design approval, or the site approval proceedings (i.e., the three prior hearing opportunities), or where the petitioner makes a showing that the plant as built does not conform with the facility license and that the nonconformance could materially and adversely affect the public health and safety.

I fully support the goal of more meaningful public participation in nuclear plant licensing decisions -- and each of the three reform bills would further that aim. I strongly believe, however, that preoperational hearings should be limited to dispute resolution of safety significant issues that were not and could not have been considered in prior facility-related hearings (on the design approval, the site approval, and the combined construction and operating license). Where an issue has already been or could have been considered in a prior proceeding, or where no safety significant nonconformance with the combined license is shown, no valid purpose is served by holding a public hearing. In short, I believe the three proposed bills strike the right balance on this matter.

Interface Problems

The third group of problems I wish to discuss involves the respective roles of the industry and its regulators in ensuring the safety of nuclear power plants. By law, the NRC is responsible for overseeing and assuring the safety of licensed nuclear activities. As a matter of functional reality, however, it is the utility-licensees who have hands-on responsibility for the safe operation of their facilities; the NRC cannot perform this function for its licensees either directly or through regulatory oversight, no matter how vigorous.

Unfortunately, the NRC's approach to regulation does not adequately reflect this simple truth. Regulation of nuclear energy in the U.S. embodies an extraordinary degree of agency paternalism and adversarial role playing -- creating relationships between the regulators and the regulated which are far different than those found in other, more successful, nuclear power programs in the free world.*/ This is reflected in the way in which the NRC imposes new requirements, particularly in the licensing review process and through later backfits; in the NRC's disposition toward prescriptive regulations; and in its manner of ensuring compliance with those regulations.

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*/ See, in this regard, the comparative description of the U.S. nuclear regulatory approach with that followed in six foreign countries surveyed (Canada, France, Japan, Sweden, the United Kingdom and the Federal Republic of Germany) in a 1982 report prepared for NRC. "Selected Review of Foreign Licensing Practices for Nuclear Power Plants". NUREG/CR-2664. In these (cont'd)

This regulatory cast of mind -- "we prescribe, you comply" -- coupled with the overly judicialized procedures which have grown up around nuclear regulation -- goes far beyond the "arms length" relationship which most of us would recognize to be a desirable regulatory posture. The safety consequences, moreover, are decidedly unsatisfactory since such an interface hampers rather than promotes timely communication and effective cooperation between the industry and its regulators on technical matters. Indeed, we have created a working interface which breeds adversarial attitudes rather than technical cooperation and which encourages licensee dependence on agency initiatives rather than licensee self-reliance. This posture of "adversarial dependence" undermines both legitimate licensee interests and sound regulatory aims. It does not take advantage of "hands-on" industry capabilities; it limits the latitude for licensee judgments which accommodate both facility management and regulatory needs; it discourages licensee innovation; and

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foreign programs, far greater reliance is placed on the facility operator to assure safety; the regulatory body follows a markedly less prescriptive approach in setting safety requirements; and the relationship between regulator and regulated is characterized not by adversarial confrontation but by collaboration in pursuing common safety aims.

it requires NRC resources for detailed supervision of licensee activities which are not available or could better be directed elsewhere.

President Carter's Commission on the Accident at Three Mile Island, the Kemeny Commission, commented critically on this phenomenon. The Commission's report warned that "[t]he existence of a vast body of regulations by NRC tends to focus industry attention narrowly on the meeting of regulations rather than on a systematic concern for safety." This "preoccupation with regulations," the Kemeny Commission feared, "may in some instances have served as a deterrent for utilities or their suppliers to take the initiative in proposing measures for improved safety." The NRC's later Rogovin Inquiry voiced related concerns about the "unintended disincentives to safety" resulting from pressures on licensees and other affected components of the nuclear industry to rely upon compliance with prescriptive NRC requirements.

While there is no single, simple way to unravel and reconstruct today's unsatisfactory interface, certain key areas will surely require NRC attention if current practices are to be constructively changed.

Uppermost, is the area of licensee responsibility. In setting regulatory requirements, Commission policy should place greater emphasis on performance objectives, rather than prescriptive detail, and should accord latitude to licensees for meeting requirements through means which satisfy both safety and cost considerations. These are necessary elements in affording practical regulatory encouragement for greater licensee initiative.

Coupled with this, should be maximum NRC emphasis on bringing about greater industry self-reliance. Commission policy should expressly recognize the desirability of, and provide regulatory incentives for, the development and use of licensee and other industry capabilities for self-initiated evaluation and follow-on improvement actions. This could well mean differentiating between licensees on the basis of demonstrated capabilities, rather than regulating for the lowest common denominator of capability as is now too often the case.

There is a companion need to recognize that judicialization of the licensing and the regulatory processes exacts a severe price. Cooperation in remedying (or anticipating) safety problems inevitably suffers where formalities delay or skew industry-NRC communication and where an adversarial environment prevails. Exchanges of views on safety matters should take place before regulatory actions are proposed and before licensees (or license applicants) make planning or resource commitments stemming from lack of knowledge, or misunderstanding, of regulatory positions.

Since the TMI accident, the industry has made substantial progress in establishing credible programs to enhance sound facility management and improve license capabilities. Most notable have been the efforts of the Institute of Nuclear Power Operations (INPO) which was created to establish benchmarks of excellence for the operation of all nuclear plants and to periodically evaluate facility operations against those benchmarks. The NRC has recognized the important contribution made by such industry programs; it needs to encourage these efforts by providing regulatory incentives for industry safety initiatives, i.e., assurance that the results of such efforts will be recognized as satisfying relevant requirements or eliminating the need for those that would otherwise be imposed. This is not so much self-regulation as it is sensible regulation.

Commissioner Asselstine's Letter

Earlier this year, Commissioner Asselstine sent letters to the Chairmen of this Subcommittee and the Senate Nuclear Regulation Subcommittee detailing his objections to the NRC's proposed licensing reform bill. I am submitting with my prepared statement a memorandum responding in detail to Commissioner Asselstine's letter. That memorandum was prepared by Barton Z. Cowan, the Chairman of the Atomic Industrial Forum's Lawyers Committee, on which I serve.

Conclusion

I commend the Chairman, the Members and the staff of this Subcommittee for convening this hearing and focusing attention on these vital issues. While my testimony has addressed a range of regulatory problems, corrective action cannot await either the ability or the moment to cure them all at once. The groundwork has already been laid, and a fairly broad consensus reached, on the central elements of constructive licensing reform -- improvement built on the foundation of design standardization. I would thus urge the Subcommittee to take up and act upon the licensing reform bills now before the Congress as a matter of first priority.

Enactment of licensing reform legislation will not, to be sure, solve all of the problems facing this country's nuclear power program -- many of which are outside the regulatory domain. But that is no reason for delaying action on a problem for which the Congress bears a special responsibility and which it alone has the power to remedy. Changing an outmoded and counterproductive licensing process is not simply nuclear regulatory reform, it is good government.

MEMORANDUM

Re: Comments on Letter from Commissioner Asselstine to Senator Simpson Concerning NRC Licensing Reform Proposal of 1985

On March 11, 1985, Commissioner James K. Asselstine, of the Nuclear Regulatory Commission, sent a letter to Senator Alan Simpson, Chairman of the Subcommittee on Nuclear Regulation of the Senate Committee on Environment and Public Works, discussing the reasons why Commissioner Asselstine cannot support the Commission's proposal for legislation concerning design approvals, early site approvals and combined construction permit and operating license ("CP/OL") (the "Nuclear Power Plant Licensing and Standardization Act of 1985"). The purpose of this memorandum is to comment on the letter of Commissioner Asselstine. Analysis of that letter shows that the conclusions by the Commissioner that the proposed bill would undermine current safety standards and unreasonably restrict the public's right to participate in licensing proceedings result from a misunderstanding by the Commissioner of the proposed bill and what it is intended to accomplish.

1. Commissioner Asselstine states:

> "The Commission has watered this down to require submission merely of 'sufficient information to support issuance of a combined construction permit and operating license.' The Commission has not explained why a combined CP/OL should require less information than the separately issued CP and OL."

Comment: Contrary to the Commissioner's statement, the combined CP/OL under the Commission's proposed bill will not require less information than the separately issued CP and OL. Nowhere does the bill state this, and the section-by-section analysis makes it clear that the contrary is intended. The bill itself would provide that the degree of information to be contained in the application must be "in accordance with the regulations of the Commission," thereby assuring that the Commission ultimately controls the degree of detail necessary. The section-by-section analysis clearly states that "with the current level of development it is possible to establish the design in sufficient detail before construction commences, and hence to identify the inspections, tests and analyses which need to be performed" to make the required safety findings. The section-by-section analysis further indicates that "specification of inspections, tests, analyses and acceptance criteria as an integral part of the combined construction permit and operating license cannot be accomplished without appropriate completeness of the applicant's facility design." Thus, the Commission states:

> "The level of design detail needed to establish such specification would define the essentially complete design which the Commission anticipates will be required for the combined construction permit application. The elements specified would necessarily address all important safety features of a plant, and the Commission would determine the level of detail necessary in the inspections, tests and analyses,

> and the acceptance criteria therefor. Thus, in order to qualify for license issuance, the applicant would be obliged to describe those features of the proposed facility with a matching completeness." (Emphasis added.)

The suggestion by Commissioner Asselstine that the combined CP/OL application be required to contain sufficient information to support issuance of both "a construction permit and an operating license" as opposed to "a combined construction permit and operating license" would establish an impossible standard to meet, and may raise antitrust questions. The statutory scheme recognizes this and specifies compensatory requirements for issuance of a combined construction permit and operating license - i.e., that inspections, tests and analyses, and the acceptance criteria therefor, be spelled out as part of the combined CP/OL application and license. Under current Commission practice, at the CP stage general architectural and engineering principles are established, and preliminary design information is provided to furnish the necessary assurance that the principles can be met. However, final design information and the inspections, tests and analyses, and their acceptance criteria are not spelled out. After the construction permit is issued, and while the plant is being constructed, tests and inspection procedures are developed and agreement is reached as to the criteria for acceptance of various aspects of the plant. However, under current practice even the Final Safety Analysis

Report at the operating license stage does not include all of these criteria. This process has inherent uncertainties and does not provide opportunity for public participation in suggesting additional inspections, tests or analyses at the front end when that would be most meaningful. Thus, far from being the restriction on information suggested by Commissioner Asselstine, the NRC proposal would increase the amount of information and detail necessary for obtaining a license while at the same time enhancing meaningful public participation. For example, take the case where intervenors are concerned that a plant will not have proper reinforcing steel bars in place after a concrete pour. Under the proposed bill, an intervenor could look at the proposed CP/OL and urge analytical requirements for design of the reinforcement, testing and acceptance criteria for ascertaining the design has been achieved, hold points on pours until inspection requirements are complete, and a requirement that pours only be allowed if the acceptance criteria have been met. In contrast, today we take a retrospective look, via contentions and allegations. Many similar examples could be provided from actual events which have occurred in licensing proceedings.

2. Commissioner Asselstine states:

> "The difficulties presented by this lowered standard are aggravated by the Commission's decision to delete the requirement in our previous bill for a

> preoperational review of the adequacy of a plant's construction, its readiness for operation, and the sufficiency of the emergency planning measures. The Commission has also declined to commit itself to preoperational reviews of significant safety issues not previously considered."

Comment: As discussed above, there is no lower safety standard or information requirement under the proposed bill.

Commissioner Asselstine's comment seems to suggest that after the combined CP/OL has been issued, the Commission will play little or no role in the review of the plant's construction, its readiness for operation or the sufficiency of emergency planning measures. The contrary is true. Because the Commission has an ongoing role in review of significant safety issues, as well as plant construction, readiness for operation and emergency planning, and because the tests, inspections and analyses, and acceptance criteria will be detailed at the front end, there is no need for the statute to require a special "preoperational review." Nothing in the proposed bill leads to a contrary conclusion or any conclusion that the Commission will not be checking on the adequacy of construction, the readiness of the plant for operation, or the sufficiency of such matters such as emergency planning. As noted by the Commission in its section-by-section analysis:

> "Specification of the required inspections, tests and analyses in the combined construction permit and operating license, i.e., before facility construction commences, would establish a clearly defined set of requirements governing the licensee and the Commission in discharging their complementary responsibilities as respects facility construction and operation. The Commission will be in a better position to assure that the plant has in fact been constructed and can be expected to operate in accordance with the license authorization. At the same time, license specifications of those requirements would enhance regulatory certainty for the facility licensee by prescribing what will be expected of the licensee in the construction and early operational phases of the plant and the bases for determining the adequacy of the licensee's performance. Importantly, this will also facilitate and make more effective public participation by providing information, prior to authorization of facility construction, of how the applicant's compliance with specified construction and operation requirements will be demonstrated following license issuance."

This makes it clear that the Commission will be utilizing the required inspections, tests and analyses, and the acceptance criteria as a detailed checklist to make certain that the applicant complies with its license obligations. With the increased discipline thus provided, the Commission Staff will know if, during construction, any requirement is not met and if the deviation affects safety. If the Commission Staff finds a deficiency during construction which affects safety, the Commission will be able to take the necessary action (including, where appropriate, enforcement action) to make certain that the plant conforms to the license and meets the statutory standards, Moreover, should changes to the inspections, tests and analyses, or acceptance criteria, arise which are of safety significance, opportunity for hearing will be afforded.

Near the end of his letter, Commissioner Asselstine recommends an approach utilizing "specified check points to assure adequate quality as construction proceeds." This suggestion is in line with the intent of the Commission bill and, in fact, is built into the concept of providing for inspections, tests and analyses, and their acceptance criteria as part of the combined CP/OL. However, it would be useful to add to the Commission bill a provision calling for a "sign-as-you-go" procedure for construction quality assurance so as to ensure the appropriate Commission review at appropriate and specified check points. Such a provision could also be expanded to allow the Commission to designate, in addition to its inspectors, engineering and inspection representatives similar to the manner in which such representatives are utilized by the Federal Aviation Administration.

3. Commissioner Asselstine states:

> "This [the provision calling for inspections, tests, analyses and acceptance criteria] ignores our unfortunate experiences in recent years with the unforeseen safety problems and with construction projects which have run into difficulties and have, in some cases, been cancelled."

Comment: This sentence seems to mix apples and oranges. In comment to 2 above, this memorandum states why the use of inspections, tests and analyses, and acceptance criteria are included in the Commission bill and why, contrary to Commissioner Asselstine's view, these will enhance the ability of the Commission to oversee construction adequacy and will provide for additional regulatory stability. One of the difficulties in regulation, as it relates to quality assurance, comes about because of lack of adequate definition up front of the quality assurance requirements and, in particular, the lack of agreement on acceptance criteria and adequately described inspections, tests and analyses which will be required. Although in some cases construction problems may have led to plant cancellations, the cause was a lack of discipline in the process. The Commission's proposed bill, with its requirement up front of tests, inspections and analyses, and of acceptance criteria therefor, should bring about the required discipline. It should be noted that many of the cancellations were for reasons not related to the construction difficulties or "safety problems." Many of the plants were canceled because of financial problems, lack of need for power, or a view of the regulatory process as a never ending morass which results in lengthening construction time without contribution to safety.

4. Commissioner Asselstine states:

> "The Commission would have done better to stick with its 1983 proposal which required it to make a formal finding that construction had been completed and that the plant would operate in conformity with the combined CP/OL, the Atomic Energy Act, and the NRC's regulations. It is worth noting that in 1983 the Commission recommended that it be required to conduct a supplemental review, prior to the commencement of operation, of any issues that were not considered in prior reviews of the facility. I see no basis to support the Commission's change in position on this important safety requirement."

Comment: Under the proposed Commission bill, the hearing for the combined CP/OL would include a hearing into the detailed requirements for the inspections, tests and analyses, and the acceptance criteria. If an intervenor believes more or different tests, etc. are required, or that the acceptance criteria are not adequate, he will be able to assert such position in the hearing process. This is more of a participatory right than he obtains today where intervenors have little or no role in determining what tests, etc. are to be conducted to demonstrate that the plant is adequate. The industry and the NRC now have sufficient experience to establish these tests and acceptance criteria up front, and the opportunity should be provided up front for intervenors and others to help establish what constitutes a complete set of requirements. This is more meaningful than the present system, unless delay is the object.

Having established these criteria up front, when it can be shown those inspections, tests and analyses and the acceptance criteria have been met and signed off by those required to inspect and review, the licensee should be entitled to start up the plant without further Commission findings. This, together with the existence of detailed checklists, provide not only the means but the incentive to do the job right. (As discussed below, this does not mean that the Commission will not review issues not previously considered prior to commencement of facility operation.) The entire theory behind a combined CP/OL is that the licensee is obtaining a license both to construct and operate a plant. Although operation only can occur if the licensee constructs the plant in compliance with the license, no second license, and hence no formal finding, is required to allow operation.

With respect to the comment on the conduct of supplemental review prior to commencement of operation, the Commission will monitor construction in order to determine that the inspections, tests and analyses have been properly performed, that the acceptance criteria have been met, and that the construction is adequate, such a process will continue throughout the course of construction and will include a review of issues which may not have been considered in prior reviews. Thus, the call for a "supplemental review" is superfluous. The time to review the work is while the work is being performed, not after the fact when the plant is complete and changes are more difficult to make. The process in the proposed bill recognizes this reality.

5. Commissioner Asselstine states:

> "The Commission's 1985 bill would place a very high threshold on the ability of a member of the public to obtain a hearing after the issuance of the combined CP/OL."

Comment: As noted by the Commission in its section-by-section analysis:

> "An opportunity for a second public hearing would be provided prior to commencement of operation of the facility if good cause exists therefor."

Commissioner Asselstine's comments equating the requirement of good cause with "a very high threshold" suggests that a second hearing should be held even in the absence of good cause. It is important to remember that at the front end detailed design information as well as the inspections, tests and analyses, and acceptance criteria are spelled out and an opportunity for hearing provided at that time. Moreover, the proposed legislation would substantially expand the potential scope of the hearing at the early stage, because inspections, tests and analyses, and the acceptance criteria would be subject to the hearing. Today, these are subject to public input, if at all, only through late allegations or the contention process at the operating license stage.

If there is to be some degree of stability and predictability in the licensing process, it seems appropriate to decide and consider issues prior to commencement of construction and prior to the investment of billions of dollars in the plant. Unless there can be a reasonable assurance that if the plant is built in accordance with the combined CP/OL and if the inspections, tests and analyses set forth in the combined CP/OL are performed and if the acceptance criteria set forth in the combined CP/OL have been met, that the plant will be permitted to go on line without a second hearing unless good cause for such hearing is shown, the entire concept of a combined CP/OL will be meaningless. The tests provided by the Commission bill to determine good cause are the appropriate tests. Unless there is a substantial dispute of fact that must be resolved, there is no reason for a hearing. Assuming such a substantial dispute of fact which needs resolution, the proposed bill requires either that the issue was not and could not have been raised in prior proceedings or that there is a nonconformance which would materially and adversely affect safe operation of the facility. If the issue could have been raised in a prior proceeding and was not, there should be no reason for a second hearing unless there is a nonconformance which materially and adversely affects safety. Conversely, if the issue does not involve a nonconformance with the combined CP/OL, there should be no reason for a second hearing unless the issue could not have been raised and resolved in a prior proceeding. One of the tradeoffs for greater specificity and detail at the front end of the process, and consequently for more meaningful public participation before the combined CP/OL is granted, is a limitation on a second hearing to those issues which could not have been decided earlier or which involve a nonconformance that affects safety. This is a functional, sensible process for public participation, not a "thicket of obstacles" as asserted by Commissioner Asselstine.

6. Commissioner Asselstine states:

> "As a practical matter, this thicket of obstacles will make it impossible for people living close to a plant to obtain a hearing on the issues such as emergency planning, adequacy of plant construction and readiness for operation, which are of greatest concern to them."

Comment: Under the proposed bill people living close to a plant would be able to obtain a hearing on issues such as emergency planning, adequacy of plant construction and readiness of operation. However, issues such as these would have to be addressed at the combined CP/OL hearing stage. We should apply the lessons of past experience with these issues in formulating hearing process improvements.

Any statutory scheme involving approval for construction of a plant cannot wait until the plant is already constructed before considering an issue such as emergency planning. With over eighty plants already on line, the Commission has had sufficient experience that it is in a position at the combined CP/OL stage to set the criteria and the inspections, tests and analyses which will be required in determining the adequacy of an emergency plan for the plant. For example, if one of the criteria for the emergency plan is the ability to notify all people within a five-mile radius of the plant of a radioactive release within a certain number of hours, this can be specified and the means by which one determines whether adequate notification procedures are in place can also be specified at the front end. It may not be possible five years in advance to list the telephone number of the local sheriff at the time the combined CP/OL is being issued, but it is possible to state that the telephone number of the local sheriff will be one of those numbers listed in the plan, and to have among the criteria for acceptance of the plant the listing of such number. The public participates at the front end as respects the foregoing by suggesting, for example, others who should be notified or the timeframes within which such notifications should take place. Thus, people living close to the plant can obtain a hearing on emergency planning issues. When the plant is ready to operate, if there is an alleged safety-significant nonconformance, a hearing would also be available.

However, it is anticipated that if an adequate job is done when the combined CP/OL is being issued, preoperational disputes respecting criteria conformance will be of limited scope and amenable to timely resolution.

7. Commissioner Asselstine states:

> "Indeed, I am persuaded that the Commission's efforts to silence the public will only stimulate opposition to future nuclear power plants."

Comment: There is no effort by the Commission "to silence the public." The effort by the Commission is to provide a logical statutory scheme whereby issues are resolved at the earliest possible time in the licensing process. Effective public participation is maximized when public input is taken into account prior to initiation of plant construction. Public participation after the plant has been constructed and is ready to cperate clearly is not as meaningful, nor is such late participation consistent with the Commission's overall goal of bringing greater stability to the licensing process.

8. Commissioner Asselstine states:

> "In addition, I would point out that the combined CP/OL, early site review, and standardized design provisions of the bill contain a statutory limitation on backfitting. Putting aside my reservations about the wisdom of the Commission's proposed backfitting standard (conditioning a backfit on a showing that it will substantially advance public health and safety by improving overall plant safety),

> I recommend that the Congress not enact these provisions. As the Commission itself noted when it submitted its 1983 proposal, this is a problem which can be better addressed in the Commission's regulations. The Commission has had relatively little experience with formal backfitting standards."

Comment: The so-called "statutory limitation on backfitting" referred to by Commissioner Asselstine is a provision designed to accord stability to the critical regulatory approvals in the new licensing process. It is, moreover, a key element in the central aim of the bill to encourage industry to seek approval and then commit to the use of standardized plant designs. A standardized plant design approval is illusory unless there is a provision to give that approval stability by limiting later regulatory modifications.

The bill itself does not provide a statutory limitation on backfitting but, rather, requires a process whereby a decision to modify a previously approved design, site or CP/OL approval is made only after disciplined consideration utilizing an appropriate test. The bill stabilizes the process but does not make these approvals immune from modifications required for safety purposes. Backfitting for other licensing approvals is left by the bill to Commission regulation.

9. Commissioner Asselstine states:

> **"To that end, I would recommend adding provisions to the bill to require that future nuclear power plant applications use essentially complete standardized plant designs which incorporate as key design elements greater simplicity, larger margins of safety, and other characteristics that promote more efficient construction, operation, maintenance and reliability. I would also recommend requiring that future plant applications use a centralized management approach for the construction project with specified check points to assure adequate quality as construction proceeds."**

Comment: There is nothing in the record that supports a call for larger margins of safety. The current plants are safe and, indeed, even Commissioner Asselstine has registered votes in favor of issuance of operating licenses, thereby signifying that he believes the current plants provide reasonable assurance for the public health and safety.

With respect to requiring provisions which incorporate as key design elements greater simplicity, there is no way that you can legislate design simplicity. (It is anomalous that Commissioner Asselstine would entrust this task, but not that of setting a backfitting standard, to the legislative process.) The same is true for attempts to legislate more efficient construction operation, maintenance and reliability. With respect to the call for requiring a "centralized management approach for the construction project," as long as people who do the job are qualified, the NRC should not be dictating the type of contractual arrangement or construction organization necessary to do the job. Some organizations are capable of utilizing a centralized management approach while others can utilize a decentralized system with equally good effect. It is a mistake to believe that the NRC has sufficient competence and practical experience, or would be prepared to become accountable, for establishing project design or management.

The idea of specific check points to assure adequate quality as construction proceeds has previously been commented upon and is, indeed, a worthwhile suggestion which should be adopted.

10. Commissioner Asselstine states:

> "As a final matter, I would suggest that you consider combining legislation for future nuclear power plant licensing with legislation to extend and modify the Price-Anderson Act. Just as licensing legislation would provide the framework for any future nuclear power plants, legislation amending and extending the Price-Anderson Act, such as that recommended by the Commission in its December 1983 report to the Congress, would provide the basis for future public protection and compensation in the event of a nuclear accident in this country. It would seem logical to consider these two related legislative initiatives together."

Comment: The logical link seen by Commissioner Asselstine between licensing legislation and modification of Price-Anderson is not readily apparent. There is nothing in the proposed bill which concerns substantive requirements involved in the Price-Anderson Act, and the Price-Anderson

Act does not involve standardization. As the Commissioner himself notes, licensing legislation is to provide the framework of future nuclear plants, while Price-Anderson relates mainly to public protection and compensation in respect to nuclear plants already licensed. Insurance indemnity, moreover, is a much different matter than the framework for licensing and constructing of the plants, involving different disciplines, analysis and approach.

Conclusion

The main difficulty with the overall approach suggested by Commissioner Asselstine's letter is that, while the Commissioner is in favor of more standardization and greater technical and operational detail at the front end of the process, his suggestions generally would undermine realization of those aims. Any proposed licensing legislation must take into account the fact that no utility is going to invest the effort and resources required to build a nuclear plant unless it has reasonable assurance that once the plant is constructed and ready to operate, it will be allowed to operate in the absence of significant safety problems. If industry discipline and commitment at the front end of the licensing process are not matched by regulatory disciplines and commitments thereafter, no new nuclear plants will be built in this country. Any licensing reform legislation that does not take this into account will be inadequate.

Mr. **Bryant**. We talked about the issues, and I wanted to ask you a question, just a sort of commonsense question—I tend to share your view, as you may have heard me say. I am asked sometimes by those that say, look, we have all the regulations in the world, all kinds of inspectors and we have got this licensing system that is so difficult and is complained about by everybody.

But yet we run into serious problems like the one we experienced down in Dallas where in spite of all these people looking over the shoulder of the company, there apparently have been some difficulties with the safety of the construction. And yet, here some of us are, including me, advocating that we need to change the regulations, make them fewer, and make them more easy to comply with.

What do we say back to those people?

Mr. **Rowden**. Well, I certainly would not say that there are no problems, or that the problems that exist do not reflect in part poor management.

I would also say, however, that no amount of regulation is going to impose nuclear safety on an industry which does not have the incentive and the capability to realize it. My own view is that the present nuclear regulatory process stands in the way of that.

I think there is a lack of clear direction as far as the NRC is concerned. This is central element behind my desire to change the NRC managerial structure to one where you have a single accountable administrator. Indeed, where the President himself is accountable.

Second, the licensing process——

Mr. **Bryant**. Who would be accountable?

Mr. **Rowden**. The President himself would be accountable. Under a single administrator appointed by the President and removable by the President, the performance of that agency—as it is for every other Federal agency that regulates safety—would lie at the doorstep of the President, so to speak, which is the way the political process should work.

Second, we have a licensing process which misallocates safety resources, which provides for safety reviews, and public participation in the process at the wrong points in time, and which licenses to an unfinished product, not a finished product. That invites the sort of problems which you have just identified.

And third, as I indicated—and this is something that I have emphasized in the past—we have a mismatch of responsibilities here. The NRC simply cannot do everything that needs to be done to assure, even to fully audit, the safety of very, very complex, technological and industrial undertaking.

That responsibility has to lie with the utility licensees themselves, and we have to assure that they are capable of carrying it out. That is one of the reasons why the foreign programs—that we point to with some puzzlement as to why they are so successful and we have not matched their degree of success—one of the basic reasons why they are successful. That truth has been recognized and is implemented in the way they carry out their nuclear programs.

Mr. **Bryant**. What truth is that?

Mr. **Rowden**. The truth is that the basic functional responsibility for carrying out safety lies with the utility operator. And, that prescriptive requirements are not going to ordain safety. There are no

Ten Commandments that the NRC can lay down that is going to assure safety. It is the capability of the utility itself that will do that.

And we have to foster a system which encourages the development of that capability, rather than stifles it, as is the case I believe now.

Mr. **Bryant**. A very fundamental question, which probably does not have any place in this hearing, but since we are almost at the end of it—what is the best answer in your opinion to those who say we really have no nuclear power future because we have got no place to put the spent fuel?

Mr. **Rowden**. The spent fuel problem, I think—in the view of most knowledgeable people in the industry—has been a political problem rather than a technical problem. Obviously the siting problem is not only a political problem, but the will to come to grips with the long-term waste management problem, I think, has been one which has been more of a deficiency in the political sector, with all due regard, up until a few years ago, than it has been in the technological sector.

The problem is manageable with techniques that are available. It is not that there are not unique aspects of it that have to be addressed. And I think the industry, and I think the Nation as a whole, was pleased that the Congress came to grips with this problem in passing the Nuclear Waste Policy Act several years ago.

I think it is an act which is basically well constructed. It is, of primary importance, soundly financed over its lifetime. And I think it provides for the sort of political accommodations that are necessary to achieve acceptable siting in the United States.

So I think this is a manageable problem, sir.

Mr. **Bryant**. Mr. Cook, you made a comment a moment ago that the industry had better be sure that they have a good site, and that they had better be sure that they did several things right.

And I am wondering if it is possible for the industry to be sure of anything. That is, they are in business to provide power, to make a profit for their stockholders, and of course, and to act responsibly, and, I think, they by and large have. But with someone regulating them, someone looking closely at what they do, are they to be sure of these things? I mean, are there enough incentives in place?

Before making that statement you had observed that they had no incentives to keep costs down and therefore they did not.

Mr. **Cook**. I think part of the trouble with the utility industry is that there has been much too great a commitment to meeting the average. But they have not been sufficiently committed to quality. And in part that may have been created by the constant problem of working within the NRC regulations.

The legislation that is proposed, insofar as it will free them to pursue ends rather than means, may be helpful in bringing about this commitment to quality. Up to now the nuclear power industry has seemed about as committed to qualify as the automobile industry.

Mr. **Bryant**. Mr. Corey, do you have a comment on the same subject?

Mr. **Corey**. My only comment would be to second what Mr. Cook said, and to add that there is nothing in the recommendations I made, or in the matter that we have been discussing generally, namely, standardized licensing, which would imply any desire on anyone's part to abandon the need for looking after public health and safety.

In fact, it is my opinion—and again, I am speaking as a financial man, not as an engineer, but based upon what I am told by my associates and former associates—that health and safety will be enhanced by simplified one-step licensing, not harmed.

Mr. BRYANT. Thank you. Mr. Sillin, any further comments?

Mr. SILLIN. No. Well, this comment. And that is is that I happen to believe that the discipline of the marketplace is a wonderful thing. And that when people—well, when an institution's ability to make a significant profit or to suffer a tremendous loss, under those conditions I tend to think that they work toward building and operating at the highest standards of excellence.

And if somebody can make a 40 or 50 percent return off a nuclear powerplant as they might under a deregulation type scenario, I think the incentive is certainly there to work toward what I call the highest standards of excellence.

Mr. BRYANT. Thank you very much. Let me make a statement here at the end, to apologize to you for the small number of members here today. We are in the midst in the Energy and Commerce Committee, of which this is a subcommittee, of the markup of the Superfund bill. I do not know whether Mr. Markey made that clear earlier or not.

Also, the House is in session at the same time marking up the appropriations for the Department of Housing and Urban Development. It has made this very difficult. Those are things that the chairman cannot anticipate when he schedules these hearings. So I want to make that clear and to say thank you very much for being here today, all of you.

I believe we will adjourn the meeting.

[The following material was supplied for inclusion in the record:]

PREPARED TESTIMONY
OF
EUGENE W. MEYER
KIDDER, PEABODY & CO. INCORPORATED

My name is Eugene W. Meyer. I am a Vice President and a member of the Management Committee of Kidder, Peabody & Co. Incorporated. For the past fifteen years, I have been responsible for Kidder Peabody's Utility Corporate Finance activities. During that period of time, Kidder, Peabody managed over $50 billion of utility security offerings. Much of the capital was used for the construction of nuclear power plants.

Ninety-seven nuclear units, totaling over 100,000 megawatts of generating capacity, were cancelled by U.S. utilities between 1972 and year-end 1982. No new nuclear units have been ordered since 1982 and, to the best of my knowledge, no new orders are contemplated.

The reason for the situation is that the business risks and financial risks of building nuclear power plants are too great for the utility industry to take. In this testimony, I propose to discuss these risks and develop a context for contemplating the future of nuclear power in the United States.

At present, there are 34 nuclear units under construction in the United States. Over $60 billion has been invested in these plants and it is estimated that approximately $30 billion more is required to complete construction. Currently, 28 utilities have more money invested in unfinished nuclear plants than the total equity in the company. If the 34 units are completed, some 37 utilities will have investments in nuclear plants exceeding total equity. Thus, about 35% of the publicly-traded utility companies will be exposed to this extraordinary risk.

Building a nuclear power plant is probably the most capital-intensive business venture in existence. The capital required to finish the plants under construction will be very expensive indeed, if it is available. It is my judgement, furthermore, that new nuclear plants, if ordered, would not be financeable by any utility. The basis of that opinion lies with the ongoing failure of many utilities to pay for the capital employed in nuclear power plant construction.

There has been a breakdown of the historic social contract between investors and ratepayers. The foundation of this contract has been regulatory law. Regulatory law provided that investors in utility facilities would be paid the cost for their capital as established in the marketplace. The dollars for this payment would come from the rates charged for the service. So long as generating stations could be built in 1-3 years, it was an inexpensive matter to add a minimal amount to the cost of the plant to pay the cost of capital during the construction period. The accounting entry to do this is called Allowance For Funds Used During Construction (AFUDC). Once the plant goes into operation, it is eligible to be included in a utility's rate base and earn a rate of return sufficient to cover the cost of capital.

For a whole variety of reasons, nuclear plants now require 6-12 years or more to build. The accumulated AFUDC over so many years of construction ballooned the costs of nuclear plants to levels which made their economic viability questionable.

The alternative to the use of AFUDC was, and still is, allowing the utility to earn a cash rate of return on plant under construction

(CWIP). Only a few state regulatory bodies chose to include CWIP, however, on the grounds that only plant that is used and useful could be included in the rate base.

Investors continued to fund plants which were denied CWIP treatment relying upon regulatory law to provide a return when the plant did become used and useful. To their chagrin and economic loss, investors are now finding that regulatory bodies who denied use of CWIP are now prepared to include plant in rate base on a phased-in basis over a period of years after it becomes used and useful. Furthermore, many regulatory bodies are denying the inclusion of major portions of the investment in rate base, alleging management imprudence.

It is furthermore a fact that utility companies are limited to a rate of return which equals the cost of capital and no more. So as the risks of financing nuclear plants have increased, there has never been an opportunity to earn a higher return commensurate with the increased risks.

If capital is to be attracted to nuclear power construction in the future, on any kind of reasonable basis, the risks borne by the investor must be reduced and the returns must be improved.

Specifically, the time period for construction must be shortened dramatically. This means conformity of design and consistency of NRC regulation. Cost increases not due to the presence of inflation cannot be tolerated if capital is to be raised.

The operating experience of the Nation's nuclear plants must continue to improve. The shared knowledge made possible by The

Institute of Nuclear Power Operations should insure progress in this area.

Most importantly, there must be a reduction in the rate regulatory risk. No nuclear plant can be financed unless legislative action is taken to ensure the use of CWIP in the rate base. The price of the plant must be established in advance on a turnkey basis. That price must be approved by regulation in advance of any capital being raised. The rules for management prudency findings must be established in advance. If a phase-in plan is to be used for rate base, it must be disclosed in advance.

Most observers, including this one, doubt that these assurances can be obtained from the current state regulatory system. Assuming that is right, it will be impossible to finance new nuclear units no matter how much improvement is made in reducing other risks.

In summary, the institution of regulation has been tested and found wanting. The regulatory system of the past and present will not permit the further development of nuclear power because it no longer functions as an effective capital-raising mechanism.

NUCLEAR POWER: IN TRANSITION TO WHERE?

by

Dr. Priscilla C. Grew, Commissioner
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Good morning. I would like to thank the Association for inviting me to participate in this program with Commissioner Asselstine of the Federal Nuclear Regulatory Commission and Mr. O'Connor, Chairman and President of Commonwealth Edison of Illinois. I have been asked to present the perspective of a state regulator who works with issues concerning nuclear power. My remarks today, of course, represent my own views, and do not necessarily reflect the position of other members of the California Public Utilities Commission.

In his introduction, Commissioner Nunnery of Wisconsin just told you that I am the first geologist to serve on the California Public Utilities Commission. I'm sure many of you in the audience who have gone through a federal or state Senate confirmation have your own war stories to tell about that particular political process. In my case, after the six months of controversy following my nomination to the California Commission by Governor Jerry Brown, our State Senators had to think up some special geological questions to ask me during my confirmation hearings last year. The first question was, would I promise, as a geologist, that the Diablo Canyon nuclear powerplant would be safe from earthquakes?

Invited address presented at the Ninety-Fourth Annual Convention and Regulatory Symposium, National Association of Regulatory Utility Commissioners, Sheraton-Boston Hotel, Boston, Massachusetts, November 11, 1982.

The second was, if in the future I thought the plant wouldn't be safe in an earthquake, would I promise not to climb over the security fence and get arrested in a demonstration? The third question was, would I promise not to raise California electric rates in the meantime?

Questions like these remind me of those medieval fairy tales in which the old wizard asks the knight in shining armor three magic questions -- if he answers them right, he gets the princess; if he answers them wrong, he's turned into a toad. Unfortunately, the stories never quite tell you what happens to a state regulatory commissioner.

On a more serious note, in my remarks this morning, I want to focus on some of the tough questions nuclear power poses for state regulatory commissioners. I must say that some of them are tougher than the wizard's questions in any fairy tale. I've decided to modify the assigned theme of my presentation: from "Nuclear Power -- In Transition to Where?" to "Where is Nuclear Power Going to Lead State Utility Commissions?"

The theme for my presentation is that while the basic decisions to expand the nation's nuclear power capacity were made in past decades by federal officials and industry executives with state regulatory concurrence, (indeed, some observers describe the state commission's role as more of a spectator than a regulator [1/]), today's and tomorrow's state commissioners are the ones who will directly assign to the ratepayers the highly controversial costs of nuclear power -- be they the costs of plant construction, repairs, deferral, cancellation, waste disposal, decommissioning, insurance or accident bail-out.

In the decade after 1945, national decisions set in motion the rapid expansion of civilian nuclear power in the United States. Today, state commissions are left to pick up the pieces amid the debris of hasty decisions.

The story is a familiar one. Congress decided in 1978 to raise natural gas prices; today state commissioners are taking the heat for passing them on in rates. The Justice Department settles with ATT; years later ratepayers will blame state commissioners for tripling the household phone bill. What I wish to convey to you today is my concern that the particular problems associated with nuclear power pose fundamental threats to state utility regulation as we have known it. Ratepayer frustration with the decisions commissions are being forced to make is already leading to popular initiatives to bypass state commissions. Consumers want to subject powerplant certification and debt issuance to plebiscite vote, rather than determination by a state commission. Industry representatives frustrated with rate awards that are insufficient to support nuclear powerplant construction costs, propose transfer of state regulatory authority to the regional or federal level.

What happens if state commissions balk at passing on nuclear plant cancellation costs to consumers? We were told Monday by Mr. Alan P. Buchmann, an Ohio attorney who represents utilities, that if state commissioners decline to assess ratepayers for the costs already invested in cancelled, unused plants, the costs nevertheless "will be paid for one way or other by the consumer,"[2/] through increased financing costs imposed by the higher risks which commission disallowances will inevitably place on the utilities. And if state commissions are reluctant to raise rates to share in accident cleanup in another state, at least some U.S. Senators think federal legislation should nudge them along. Earlier this year Senator John Heinz, Republican of Pennsylvania, proposed a levy of "28 cents on each kilowatt of nuclear-generated power throughout the nation"[3/] to raise cleanup money for Three Mile Island, because, as Senator J. Bennett Johnston, Democrat of Louisiana, argued, "free enterprise can't do it alone."[3/]

Although Massachusetts Senator Paul Tsongas argued "It would be cheaper to make it [Three Mile Island] a national park,"[5] the bill passed the Senate Energy Committee in April, with Senator Wendell Ford, Democrat of Kentucky, saying that the bill was "a bad precedent. But I'm going to vote for it because I don't want to see that soggy bottom floating down my way."[6]

The dialogue sounds like "Saturday Night Live" until you suddenly realize that you've got to deal with it in the hearing room on Monday morning. What I'm going to do in this talk is point out some nuclear power issues that have the potential to change the institution of state utility regulation. I'm going to put them together in a little drama: a day in the life of the beleaguered state commissioner, the Honorable Walter Mitty (with apologies to James Thurber). We're going to run through the events of the Honorable Mr. Mitty's day, and include a look at the information overload in Mitty's in-box. The headlines you are about to hear -- are real.

Monday morning. Commissioner Mitty arrives at his office, checks out the latest sexual harassment memorandum from the personnel office taped to his chair by his secretary, and begins to examine the 23-inch stack of paper on his desk -- it's the electric company's $3.4 billion application for its new nuclear powerplant that was price tagged at $436 million when certificated.[7] Marking that stack for file, Mitty turns to the morning headlines: "100,000 SEEN DYING IN NUCLEAR ACCIDENT".[8] "Oh, I hadn't heard about that," thinks Mitty. Ten o'clock. The appointment with that group of environmentalists -- they want Mitty to withdraw the certificate of public convenience and necessity for the almost finished $3 billion nuclear powerplant that the old Honorable Bill and Joe approved back in '67.

Lunch time. Honorable Mitty has his customary peanut butter sandwich at his desk, and starts his in-box. First, the easy part, the press clips. "AMERICAN EXPRESS UNVEILS PLAN FOR U.S. TO HELP WASHINGTON POWER PAY OFF DEBT."[9] "Yes, I know it's always best to ask for travelers' checks by name," thinks Mitty. "UTILITIES LOSE COURT ROUND OVER THE BONDS FOR 2 PLANTS JUNKED BY WASHINGTON POWER."[10] "I didn't think the Wall Street Journal used slang like that," thinks Mitty. "COUNTER-TERRORISTS SEIZED ATOM PLANT IN '80 SECURITY TEST."[11] "I'm glad those government guys are right in there, on the ball," Mitty says approvingly. "NUCLEAR 'TURKEY' ON CONGRESS MENU."[12] "Oh, that's the breeder reactor, not one of ours," Mitty says, relieved. "SIRENS IN SAN LUIS OBISPO: THEY'RE NOT EXACTLY FOR MELTED HEARTS."[13] "That Los Angeles Times headliner is getting pretty raunchy," Mitty mutters, raising his eyebrows.

Two o'clock. It's meeting time again. Staff has an innovative proposal for utility incentives to increase the operating efficiency at the new nuclear powerplant. Staff says, let's take the utility's most recent operating estimate, 65% percent of capacity, as the standard, and provide rate base penalties and rewards for the deviations. But Mitty's trusty legal adviser, Tonto, offers the caution that incentives for higher operating levels would actually be incentives for the utility to cut corners on plant operating safety. Also, Tonto points out, the ratepayers thought that the plant is supposed to operate anyway -- "they'll be mad if you raise the rates if the plant turns out to surprise everyone and operates more than 65% of the time," he tells Mitty. The phone rings, and a pesky investigative reporter wants to know why Mitty, instead of the NRC, didn't find out that two of the new nuclear plant's blueprints were backwards.

Mitty explains the federal role.

Three o'clock. Another reporter catches Mitty on the way to the water fountain. "Mitty, what do you have to say about that new NRC study by Sandia Labs that says a worst case accident at the Millstone Reactor, yeah, that's right, 'Millstone', could cause 23,000 first year deaths?[14] I want to know, because the boys at the New York Times reported the price tag for Millstone is now $3.54 billion for 1150 megawatts."[15] Mitty says he'll look into it. Fortunately, by the time Mitty returns to his office, Tonto has clipped the article in the afternoon paper, "NRC ISSUES DENIAL ON DISASTER ODDS."[16]

Mitty settles back into his comfortable chair and begins reading items in his in-box again. First, there's a staff report from another state commission. Mitty likes to keep up with what the other states are doing. "After all, we're all in this thing together," he sighs. "Well, here's a report by the staff of the Illinois Service Commission:"

> For the Commission must also acknowledge that Commonwealth Edison's ratepayers also face difficult economic times and have already made substantial sacrifices in the form of higher rates ($893.2 million higher since February, 1980)... despite these record rate increases which were based upon substantial amounts of construction work in progress in rate base and upon some of the highest returns on equity allowed any utility in the nation, Commonwealth Edison is in the same critical condition in which it has been for the last three years. For the third year in a row, it now requires emergency interim relief in order to stave off further downgrading of its bonds... With the timely and economical completion of the [nuclear] construction program hanging in the balance, the instant proceeding will have significant effects on the future infrastructure of Northern Illinois and the long-run viability of the Chicago area economy.[17]

Mitty sits back and remarks, "We state regulators really have a lot riding on our decisions, don't we?" Mitty picks up the next item, a lead article from the Wall Street Journal: "RATE SHOCK: ELECTRICITY COSTS RISE SHARPLY AS UTILITIES ADD NEW NUCLEAR FACILITIES."

> The unpleasant arithmetic should be felt by consumers around the nation over the next couple of years. Pennsylvania Power & Light Co. estimates that its two Susquehanna nuclear units... could raise customer rates 35% to 40% from current levels... Mississippi Power & Light says its rates will have to increase 30% when its Grand Gulf Nuclear Station comes into operation... When Kansas Gas & Electric Co. opens the Wolf Creek nuclear plant,... it will be able to say that it is the smallest utility running a nuclear plant. It may also enjoy the dubious distinction of having the biggest rate increase ever required to pay for such a facility. Estimates of of the increase run about 60%. 18/

"Well, what can we do about those increases?" wonders Mitty. "Oh, here's a suggestion further down in the article."

> ... utilities in similar straits would be aided by any spurt in oil prices. Higher prices would reduce the discrepancy between what new plants cost and the cost of oil that nuclear power replaces. A sharp increase in oil prices would reduce the political problems engendered by socking customers immediately by plant construction costs. "I imagine utility executives have worn out several prayer rugs hoping for higher oil prices," jokes a staff member of the New York Public Service Commission.19/

"Maybe there's a chance oil prices will go up," thinks Mitty. Time to get a financial point of view. "O.K., here's one -- a news letter from the utility finance department of a national corporate finance service. Well, let's see, where are the latest bond ratings and the list of granted rates of return? Oh, here's something: "ANOTHER PART OF THE NUCLEAR DONNYBROOK":

> Recently, the Nuclear Regulatory Commission ordered the operators of the nuclear-fueled Indian Point Units 2 and 3 [in New York] to provide a 'satisfactory' emergency plan by mid-December, or the operating permit would be revoked. The operators, Consolidated Edison of New York and The Power Authority of the State of New York, have submitted plans, but they have not been accepted by the Federal Emergency Management Agency, or, perhaps more importantly, by the Legislature of Rockland County which is just across

> the river from the facility... Meanwhile, Rockland County legislators voted to withdraw from the emergency preparations and want to be compensated for expenditures to date... We wish the NRC all the luck in the world in meeting its deadline, but we note that in painting a room you back toward the door, not away from it.20/

"I remember Mrs. Mitty telling me the same thing," recalls our Commissioner. "Let's see what's coming out from the feds -- COURT UPHOLDS FERC RULING ON COST ALLOCATION FOR CANCELLED NUCLEAR PLANT":

> FERC's allocation of charges for the cancelled Tyrone, Wisconsin, nuclear powerplant, challenged by the South Dakota and Minnesota public utilities commissions, has been upheld by the 8th U.S. Circuit Court of Appeals. ... the Wisconsin Public Service Commission in 1979 denied Northern States Power the authority to build the Tyrone Plant... FERC's decision... assigned 87% of $67 million in costs to NSP-Minnesota's customers in South Dakota, North Dakota, and Minnesota, and the remaining 13% to NSP-Wisconsin's customers. The two state commissions had charged Wisconsin with advancing its 'parochial state interests,' arguing that customers in their states shouldn't have to pay for a plant that was... cancelled by one state's action.21/

"Yes, I always was for states' rights," thinks Mitty -- but then the phone rings, it's Mrs. Mitty on the line. "Dear, you'll be late for dinner with the Millers, you didn't fix the sink this morning, and don't forget to pick up the chintz curtains on the way home" -- so we now leave the Honorable Mr. Mitty with his mind cleared of the dilemmas of nuclear power for yet another evening.

Well, where is nuclear power leading state commissions? Into uncharted waters where they must parcel out blame for enormous cost overruns, assess responsibility for stress corrosion and hydrogen embrittlement among shareholders and ratepayers, and meet with ever increasing public resistance to paying the bills. In states with elected commissioners, appointed ones are demanded; where a governor appoints commissioners, voters want elected commissioners to represent them. Fed up with commission decisions, ratepayers want to decide on nuclear powerplants and nuclear waste disposal by popular vote; witness the two-to-one victory for Question 3 in Massachusetts last week -- a proposition that lost in only one of Massachusetts' 351 cities and towns.[22/]

Already suffering from high unemployment, recession, and financial fears for the future, and saddled with very large NGPA gas increases imposed this year, ratepayers are increasingly upset about paying for cancelled nuclear plants. The cost overruns in nuclear construction are diminishing the credibility of state commissions. Ratepayers want to know why state commissioners didn't stop projects from going way over budget, and why they didn't oversee the construction more carefully. And consumers are not satisfied with finger pointing at the NRC. Furthermore, we have not yet begun to see the ratepayer and taxpayer reaction to paying, not for kilowatt-hours, but for nuclear garbarge disposal and plant decommissioning.

In just the few days of this conference, we have been exposed to new comments in this debate. On Monday, we heard J. Hunter Chiles, III, Director of Policy, Planning, and Analysis of the Department of Energy, say that nuclear powerplants should not be cancelled on the "economically irrelevant grounds that there is no need for the power."[23/] On Tuesday, over breakfast, we read the reaction of the New York Times' editor to the opening in Manhattan of the $4 billion damage suit over Three Mile Island. The editor, noting the charges and countercharges flying between General Public Utilities and Babcock and Wilcox, wrote,

> "A verdict is not expected for many months. In the meantime, the public will have to live with the awesome possibility that both members of the nuclear establishment may be correct in their opinion of the other."[24/]

Where is nuclear power going to take state commissions? And, I might add, where is it going to take utility management, rate case attorneys, and Wall Street analysts with their careers on the line? (You guessed it -- the attorney always gets the girl at the end of the movie.)

Where did nuclear power take Jerry Brown, soon-to-be Governor Emeritus of the State of California? Now, as many of you know, if it hadn't been for Governor Moonbeam of "Windmill and Woodchip" fame, right now I'd be delivering a quiet lecture on uranium mineralization to a bunch of geology graduate students at U.C.L.A. Well, last week the voters sent Jerry Brown a one-way ticket to private life. They didn't like how he told people this was an era of limits, how he bothered everybody about Diablo Canyon even before the reversed blueprints turned up, and how he had a campaign commercial that showed a "nuke" going off in living color during the TV dinner in the family den. Well, even though Jerry lost, I'm proud to be his protegée. He taught me a lot about how to look to the future; how not to be scared of losing; and how to embrace change, not fight it. I feel I'm going to need everything he taught me in the next few years -- a period in which the challenges of nuclear power could fundamentally force changes in state utility regulation as we know it. Why do I think it will do that? Dick Gravelle, one of our California Commissioners, likes to talk about his favorite ratepayer, Joe Sixpack. Well, Joe Sixpack is fed up with being charged by state commissions for something he thinks he never agreed to buy -- that nuclear plant that the big boys decided to cancel to save the Wall Street bond rating; that nuclear waste disposal project that Mrs. Jones, the bird watcher, says is going to pollute some national park; the clean-up bill for that nuclear plant 3,000 miles away that Joe only saw on TV twice; the rate hike to pay for that cost-plus construction deal for the nuclear plant upstate. What can be done about Joe Sixpack's frustration? Well, there is the Washington solution described by Alan Abelson in Barron's:

> If the world would only follow Washington's shining example, all human woes would vanish from the face of the earth. But you know how the world is, there is no telling it anything. The fact is, hardly a day goes by but that Congress and the Administration, in splendid harmony, demonstrate that there is no problem so great that it must be faced.[25/]

One thing we must do is try to face these problems, and try to level with the ratepayers. We need to cope with nuclear power in this country. Nuclear power isn't going to be a free lunch, and by now the secret's out. We also need to level with people about nuclear powerplant risks and the trade-offs between risks and costs.

In the early days, it was said that nuclear power "could free industrial society permanently from all practical bounds,"[26/] and the Chancellor of the University of Chicago predicted that nuclear "utilities will be so cheap that their cost can hardly be reckoned."[27/] But even in the early days, there were the doubters. In 1953, Leland Olds, who had been Chairman of the Federal Power Commission under FDR, wrote "Atomic power offers no quick road to lower utility rates."[28/] Why was there such a disparity in cost estimates? I think it's because, as Alvin Weinberg, the former Director of Oak Ridge, said in a recent interview, "There was a fundamental tug-of-war between 'safe as possible' and 'cheap as possible'."[29/] Edward Teller told the Congressional Joint Committee on Atomic Energy in 1953,

> No legislation will be able to stop future accidents and avoid completely occasional loss of life. It is my opinion that the unavoidable danger which will remain after all reasonable controls have been employed must not stand in the way of rapid development of nuclear power.[30/]

What was not reckoned with was the public's interpretation of the phrase "the unavoidable danger" and "all reasonable controls." As Cora B. Marrett, Professor of Sociology and Afro-American Studies at the University of Wisconsin and Member of the Kemeny Commission on Three Mile Island, has written,

> There are risks that can be assessed in a mathematical statistical sense... [But] beyond these technical assessments of energy alternatives are public perceptions of risk. There is a wide gap between the public's perception of nuclear risk and the expert analysis of the risk associated with nuclear energy.31/

This credibility gap widens with revelations of embrittled pressure vessels, leaks of radioactive water, human errors in plant operation, computerized probability calculations, screwed up blueprints, cost overruns ten times original estimates, rate increases for plants never finished. And, of course, I have not even mentioned the public's partially sublimated concerns about nuclear bombs which are designed to go off, concerns which spill over onto nuclear plants which are designed not to. Nuclear power is the classical example of the fairy godmother who didn't deliver.

Despite pressure from the Reagan Administration to the contrary, we must keep pushing for a diversified energy mix in the nation, including investments in conservation. If we do not, we will remain mired in the rut that Peter Bradford has described:

> The [Reagan] Administration's all out budgetary attack on the alternatives to nuclear energy will continue the delusion that this is a privileged and an inevitable technology, to which much must be sacrificed. This is precisely the attitude that pushed nuclear energy too fast for its operating experience in the last decade... The industry's basic problems lie in an omnivorous dream of growth that swept aside sensible regulation, sensible utility planning, and sensible government attention to the side effects.32/

But we know we can't leave it to the feds. We, the state commissioners, are going to have to make up solutions as we go along. One thing is certain, nuclear power is going to leave a permanent imprint on the state regulatory process. If present trends continue, commissioners who approved new power plants too casually in the past will be supplanted by those who approve no powerplants at all; utilities who can't document cost control in plant construction will be stripped of their traditional management discretion; technical experts who say only they know which energy source is best will be superceded by the TV salesmen.

But possibly the most profound change will be a permanently ingrained skepticism and resistance in the American ratepayer to investment in future electric powerplants -- and this resistance to investment in the nation's energy future may well be the most devastating legacy of this troubled period.

FOOTNOTES

1. "An understaffed and underfunded Illinois Commerce Commission, which acted more like a spectator than a regulator as [Commonwealth] Edison plunged ahead with its [nuclear] construction program...," Alfredo S. Lanier, "The High Cost of Letting Edison Do It," *Chicago*, November 1982, p.173.

2. Alan P. Buchmann, (Squire, Sanders and Demsey, Cleveland, Ohio), "Cancellation or Deferral of New Plant Construction," speech at the 94th NARUC Annual Convention, Boston, Massachusetts, November 8, 1982.

3. Editorial, "Clean Up Your Own Mess," *San Diego Mercury*, August 2, 1982.

4. "A Bill to Make Utilities Share TMI Cleanup Costs," *Sacramento Bee*, April 1, 1982.

5. *Ibid*.

6. *Ibid*.

7. For example, Southern California Edison, "Cost and Controls Study of San Onofre Units 2 and 3," Application 82-02-40, Exhibit SCE-5, February 1982: "The initial capital cost for San Onofre Units 2 and 3 of $436 million...," p.3-1; "Ultimate Cost of Project, Forecast Data April 1981, $3,430,000,000," Table 3-3, p.3-9.

8. Milton R. Benjamin, "100,000 Seen Dying in Nuclear Accident: New Study Estimates Worst-Case Scenario in Power Plant Disaster," *Los Angeles Times*. November 1, 1982. "Rep. Edward J. Markey, (D-Mass.) Chairman of the House Interior and Insular Affairs Subcommittee on Oversight and Investigation, obtained the computer results submitted by Sandia to the NRC... Markey made this information available to the Washington Post."

9. John R. Emshwiller and Norman Thorpe, "American Express Unveils Plan for U.S. to Help Washington Power Pay Off Debt," *Wall Street Journal*, September 29, 1982. Shearson/American Express "unveiled a plan to tap the federal treasury to pay off $2.25 billion of the supply system's debt... The $2.25 billion of bonds for units No. 4 and 5 aren't federally backed. The 88 municipal utilities involved face principal and interest payments of about $7 billion as the bonds mature during the next 36 years... At the time the two units, known as No. 4 and No. 5, were cancelled, the projected cost of the five [Washington Public Power Supply System] units topped $23 billion."

10. "Utilities Lose Court Round Over the Bonds For 2 Plants Junked by Washington Power," *Wall Street Journal*, October 18, 1982. "A Washington State Court ruling Friday took a limited but important step toward requiring 88 municipal utilities to pay interest and debt service on $2.25 billion in bonds on two abandoned, incomplete nuclear powerplants on the Washingon Public Power Supply System...

10. (cont'd) Judge Coleman's summary judgment on the interpretation of the contract contradicts two earlier state court decisions in Oregon and Wyoming exempting utilities under their own state laws from having to pay a share of the power systems bonds."

11. Milton R. Benjamin, "Counter-Terrorists Seized Atom Plant in '80 Security Test," Los Angeles Times, September 17, 1982. "If the security experts who penetrated one of the three reactors at the South Carolina facility -- where all the plutonium and tritium for America's nuclear weapons are produced -- had actually been terrorists intent on sabotage, they could have triggered an accident that might have led to a meltdown, sources said."

12. Frank von Hippel, "Nuclear 'Turkey' on Congress Menu: Energy Economics Have Changed Need for $3 Billion Reactor," Los Angeles Times. August 22, 1982. "With a tenfold reduction in expected demand for uranium, it may be a century before the price of uranium can be expected to reach the level that would make breeder reactors [such as the Clinch River project] economical." Judith Miller, in "Cost of Reactor Seen as Doubled," New York Times, September 24, 1982, reported that the General Accounting Office has concluded that the Clinch River project "could cost about $8 billion, more than twice the Reagan Administration's estimate."

13. Richard Schmidt, "Sirens in San Luis Obispo: They're Not Exactly for Melted Hearts," Los Angeles Times, August 18, 1982. "... the coastal portions of San Luis Obispo County were reminded of another type of nuclear presence when, on the day after Hiroshima Day, the area's 89 emergency warning sirens [for the Diablo Canyon nuclear powerplant] were tested for the first time."

14. "Nuclear Plant Disaster Estimates," San Francisco Chronicle, November 2, 1982, figure for the Millstone facility, Waterford, Connecticut, from a list supplied by the Investigations Subcommittee staff of the House Interior Committee.

15. "Cost Revised on Millstone Reactor," New York Times, September 12, 1982.

16. "NRC Issues Denial on Disaster Odds," San Francisco Chronicle, November 2, 1982. "Dr. Robert Bonero, Director of the Commission's Risk Analysis Division, said the chances of such a catastrophe were 'less than the chance of a loaded Boeing 747 crashing into a Super Bowl'"

17. State of Illinois, Illinois Commerce Commission, Staff Report in Docket No. 82-0026, Commonwealth Edison Company Proposed General Increase in Electric Rates, April 16, 1982.

18. John R. Emshwiller, "Rate Shock: Electricity Costs Rise Sharply As Utilities Add New Nuclear Facilities," Wall Street Journal, August 11, 1982.

19. Ibid.

20. Kenneth Hollister, "Another Part of the Nuclear Donnybrook," Utility Trends, Corporation Finance, Utility Finance Department, Dean Witter Reynolds, Inc., September 1982, pp.5-6.

21. "Court Upholds FERC Ruling on Cost Allocation for Cancelled Nuclear Plant," Inside FERC (McGraw-Hill), November 1, 1982, p.8.

22. Jerry Ackerman, "Battles Ahead on Waste Issue," Boston Globe, November 4, 1982. Question 3 passed by a two-to-one margin, requiring legislative and voter approval for nuclear powerplants or low-level radioactive waste storage and disposal facilities.

23. J. Hunter Chiles, III, (Director of Policy, Planning and Analysis, U.S. Department of Energy), "Regulation in a Changing Society: Have the Goals Been Altered?," speech at the 94th NARUC Annual Convention, Boston, Massachusetts, November 8, 1982.

24. Editorial, "Pot and Kettle," New York Times. November 9, 1982.

25. Alan Abelson, Editor or Barron's, in his column, Up & Down Wall Street, quoted in the Wall Street Journal, September 15, 1982.

26. Daniel Ford, "A Reporter at Large: The Cult of the Atom-I," New Yorker, October 25, 1982, p.111.

27. Ibid., a statement by Robert M. Hutchins, Chancellor of the University of Chicago.

28. Leland Olds, "Big Business Moves In (1953)," article in The Nation, reprinted in America's Energy, Pantheon Books, New York, 1980, p.320. Olds was Chairman of the Federal Power Commission (appointed by Franklin Delano Roosevelt) from 1939 to 1947.

29. Alvin Weinberg, quoted in Daniel Ford, op.cit., p.135.

30. Edward Teller, 1953, in a briefing to the Joint Committee on Atomic Energy as it considered the proposed Atomic Energy Act of 1954, quoted in Daniel Ford, op.cit., p.120.

31. Cora B. Marrett, "Three Mile Island: Social Impact," in Final Report of the Conference on Public Utilities and Public Policy sponsored by the Financial Women's Association of New York, November 7-9, 1980, p.8.

32. Peter A. Bradford, "Reagan and Nuclear Power: Script by the Marx Brothers," Los Angeles Times, June 6, 1982.

Institutional Plan for the Institute of Nuclear Power Operations

MAY 1985

Executive Summary

The nuclear electric utility industry established the Institute of Nuclear Power Operations (INPO) in 1979 to promote improved safety and reliability in the operation of its nuclear plants. After its formation, the Institute grew from a handful of on-loan personnel in late 1979 to an established work force of over 400 permanent and on-loan personnel. INPO's early years were marked by growth and evolution of the Institute's programs and organization.

The Institute now focuses on improvements in established programs and refinement of methods and products.

For INPO to carry out its role, it must have the support of its members and participants and the cooperation of the U.S. Nuclear Regulatory Commission (NRC). A basis for that support and cooperation is an understanding of INPO's role. This plan is intended to provide that basis by defining INPO's role. The plan defines the major programs currently in effect. It considers the existing and projected needs of the industry and the overall environment in which INPO and its member utilities and participants operate.

In forming INPO, the nuclear utility industry took an unusual step. In committing to meet INPO's criteria and to implement improvements in response to INPO recommendations, the industry clearly established and accepted a form of self-regulation by peer review. Of the many initiatives in recent years in self-regulation, most have been sponsored and overseen by the government. The nuclear utility industry, however, formed INPO and placed itself in the role of overseeing INPO activities, while at the same time endowing INPO with ample authority to bring pressure for change on individual members. That feature makes INPO unique. The industry's recognition that all nuclear utilities are affected by the action of any one served as a principal motivation for this initiative.

Each individual member utility has the responsibility for the safe operation of its nuclear plant(s). The NRC has statutory responsibility for overseeing the licensees and ensuring that each licensee operates its facility in compliance with federal regulations. Compliance with regulations alone, however, does not necessarily ensure the best possible performance. INPO's role is to promote excellence in the construction and operation of its members' nuclear power plants.

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1.

Purpose

The purpose of this Institutional Plan is to describe established INPO programs and to provide a foundation for carrying out these programs. This plan accomplishes the following:

- updates and supersedes the Institutional Plan of May 1983 and the original organization plan, incorporating actions by the Board of Directors since the original plan was issued in September 1979
- sets forth the mission and philosophy of operations for the Institute
- describes the organization of the Institute
- describes the programs the Institute is expected to carry out, including objectives of each program
- defines INPO's role in the industry—its relationship with its members and participants, other industry organizations, and government agencies

2.

Background

The Institute of Nuclear Power Operations was established in 1979. An organization plan was developed with the assistance of several industry groups formed for that purpose. The original organization plan was issued by INPO's founders in September 1979. (The founding groups are listed in Appendix C.) U.S. utilities with operating licenses or construction permits for nuclear plants were involved in INPO's development, and all became members soon after the Institute was formed.

The Institute was incorporated as a nonprofit corporation in the State of Delaware on October 12, 1979, and began operation in Atlanta, Georgia, on December 3, 1979. INPO developed rapidly as it endeavored to implement the organization plan and carry out the safety and reliability mission established by the founders.

The original plan served as a foundation for INPO's development. The post-TMI period was one of rapid change for the industry, requiring INPO to undertake additional initiatives. Over its first few years, the Institute's role evolved to accommodate changing requirements in the industry and to build on the experience gained. Significant changes were made to the original organization, and new programs were added.

This period of development was guided by INPO's Board of Directors, with the advice of its Advisory Council, and by INPO management, with the advice and counsel of Industry Review Groups, as intended by the Institute's founders. The original organization and programs were modified to best achieve the Institute's mission.

After three years of continued growth, the Institute entered a phase of consolidation. Emphasis was no longer on growth; improvements in and refinements to established programs became the Institute's focus, and INPO's emerging role was defined in an Institutional Plan issued in May 1983.

By 1985, at five years of age, the Institute's role and programs are well-defined. While strong emphasis on improving established programs and on refining methods and products continues, INPO and its Board of Directors stay abreast of issues affecting the nuclear utility industry, and the Institute can undertake modification or additions to its programs in response to industry needs at any time.

3.

Organization

The Institute's organization is similar in many ways to a typical U.S. corporation. A board of directors oversees the operations and activities of the Institute. Board members are utility executives or senior managers elected by INPO's member utilities. The president of the Institute is elected by and reports to the Board of Directors. The Institute's technical and support divisions report to the president.

An Advisory Council of professionals from outside the industry reviews Institute activities and provides advice on broad objectives and methods to the Board of Directors. The Advisory Council is composed of distinguished professionals in areas related to the Institute's activities and includes prominent educators, scientists, industrialists, and health specialists.

An Industry Review Group (IRG), made up of professionals from member utilities, is established for each technical division. These IRGs provide advice and feedback to the director of the respective INPO division. The IRGs may also be requested to conduct specific review or audit functions by the president or the Board of Directors.

An Industry Communications Council (ICC), made up of professionals from member utilities, provides advice to the director of the Communications Division, with emphasis on emergency preparedness communications.

Non-U.S. nuclear utility organizations actively participate in INPO's International Participant Program. The International Participant Advisory Committee provides advice to the director of INPO's International and Supplier Division. Membership of the International Participant Advisory Committee consists of one professional from each international participant.

Nuclear steam supply system suppliers and architect-engineering and construction firms involved in nuclear work are eligible for participation in INPO. The Supplier Participant Advisory Committee provides advice on INPO's Supplier Participant Program. Membership of the Supplier Participant Advisory Committee consists of one professional from each supplier participant.

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4.

Mission and Philosophy of Operation

The mission of the Institute is to promote the highest levels of safety and reliability—to promote excellence—in the operation of nuclear electric generating plants.

In carrying out this mission, the Institute strives to carry out the following principles:

- Encourage excellence in all phases of construction and operation.*
- Provide guidance for its members' use in training and qualifying personnel to operate, maintain, and support their nuclear plants.
- Assist members in achieving accreditation of performance-based training programs at their facilities.
- Analyze events that occur in construction, testing, and operation of nuclear plants worldwide to identify possible precursors of more serious events, and disseminate the lessons learned.
- Involve personnel from member utilities and participants in INPO work to promote exchange of information and to ensure INPO programs meet the current needs of members and participants.
- Use expertise and experience from outside the U.S. nuclear utility industry to provide industry access to the best methods and technologies available, including exchange of information with non-U.S. organizations.
- Promote exchange of information and good practices among members and participants; recognize the importance of improving or refining existing utility practices, rather than supplanting them.
- Assist member utilities in implementing their own improvements, rather than attempting to preempt their management responsibility.
- Promote improved human resource management in the industry, including activities such as educational assistance, recruiting, screening, selection, and retention of key personnel.
- Assist member utilities in mobilizing the resources of the nuclear industry to meet the needs of an emergency.

Programs to carry out the Institute's mission and to implement its philosophy of operation are described in general terms in the next section.

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*Construction and operation are used in a broad context in this document, with construction implying construction quality and design control and operations including all phases of plant operations such as training, maintenance, technical support, etc.

5.

Programs and Activities—Overview

INPO's programs are described in detail in Appendix A; the following provides an overview of the Institute's major activities:

A. EVALUATION PROGRAM

Evaluations are conducted of nuclear plants under construction or operated by member utilities. Evaluations of corporate support of construction projects and operating plants are conducted. In these evaluations, the INPO teams use standards of excellence based on experience and best practices as a basis. Written performance objectives and criteria are used to guide the evaluation process.

B. DEVELOPMENT OF DOCUMENTS—CRITERIA, GUIDELINES, GOOD PRACTICES, ETC.

Several categories of documents are developed and designed to assist member utilities and participants in their efforts to achieve excellence in training programs and in construction, operation, maintenance, and support of nuclear plants. Key categories of INPO documents are as follows:

1. Performance objectives and criteria documents provide a basis for INPO evaluation and accreditation programs. Members are expected to strive to meet the objectives and criteria set forth in these documents.

2. Guidelines establish the basis for sound programs in selected areas of plant construction, operation, or training. Member utilities are expected to strive to meet the intent of INPO guidelines.

3. Good practices are provided to assist member utilities. They can be used as furnished, modified, or not used if an alternate approach is considered as good or better by the member utility.

4. Various other documents are produced by INPO, such as evaluation reports and special reports or studies.

C. ACCREDITATION OF TRAINING PROGRAMS

INPO assists all members in preparing for and achieving accreditation of training programs for personnel involved in the operation, maintenance, and support of nuclear plants.

D. ANALYSIS OF REPORTED EVENTS

Off-normal events that occur in the construction, testing, and operation of nuclear plants are analyzed by INPO. Lessons learned are promptly disseminated to members and participants, and on-site reviews of corrective actions are conducted at the plants of member utilities as part of the ongoing evaluation program. The events analysis program is designed to identify precursors of potentially more serious events and to correct the root causes of these events.

E. ASSISTANCE TO MEMBERS

Assistance to member utilities in their efforts to achieve excellence takes several forms:

1. As nuclear construction projects in the United States near completion, an evaluation team makes an assistance visit to each project when it is in the near-term operating license (NTOL) phase. The purpose of this visit is to assist the member in preparing to operate the new plant safely and reliably. Corporate assist visits may also be conducted in conjunction with NTOL assist visits.

2. Special visits to member or participant utilities by INPO personnel in response to requests by the utilities are one of the most important areas of assistance. They are independent of INPO's evaluation and accreditation program (though a request for such visits frequently stems from an evaluation) and are intended solely to assist members in improving their operations.

3. INPO personnel observe and comment on emergency preparedness drills and exercises as an ongoing form of assistance.

4. Various workshops and seminars are conducted to assist members in exchanging information.

5. The sharing of information or good practices and the good practice documents described previously are a form of assistance to members.

F. INFORMATION EXCHANGE/DATA BASE RESOURCES/ NUCLEAR PLANT RELIABILITY DATA SYSTEM (NPRDS)

INPO manages NUCLEAR NETWORK®, a worldwide computerized electronic messaging system. The NETWORK system is used by INPO and its members and participants for the exchange of information on construction, operation, maintenance, and support of nuclear plants. Additionally, INPO operates an extensive computer complex to provide members and participants access to data in areas such as training, job and task analysis, operating experience, and equipment reliability. One such data base on the INPO computer is the NPRDS, which provides reliability data on nuclear plant systems and components that are important to nuclear plant safety and reliability.

G. INTERNATIONAL PARTICIPANT PROGRAM

Utility organizations in other countries are eligible to become participants in INPO. This self-supporting program is intended to facilitate exchange of information and experience, thereby promoting safe and reliable nuclear plant operation worldwide. International participants receive all INPO products provided to domestic members and are invited to INPO workshops. Assistance visits and technical exchange meetings are conducted both in the United States and abroad. International participants are afforded access to INPO's experience and can adopt INPO methods, as desired, in areas such as plant evaluations and training program accreditation.

H. SUPPLIER PARTICIPANT PROGRAM

Nuclear steam system suppliers and engineering and construction firms involved in the design, engineering, and construction of major portions of commercial nuclear plants are eligible to participate in INPO. This program is intended to promote exchange of technical information and to translate user experience to designers and manufacturers.

I. LOANED EMPLOYEE AND LIAISON ENGINEER PROGRAMS

INPO relies heavily on loaned employees from members and participants. This program is designed to provide a continuing source of personnel with recent utility and industry experience to augment the INPO staff. It also provides the loaned personnel with an opportunity to gain broader experience in the industry.

In 1984, as a means of furthering industry experience and opportunities, a reverse loanee program was implemented in which, under special circumstances, INPO employees are loaned to member organizations.

International participants and international supplier participants are eligible to assign a liaison engineer to the INPO staff. This program is intended to provide ongoing liaison with the participant organization and to provide INPO staff support.

A sizeable percentage of INPO's technical staff is on loan or liaison engineers.

J. INPO STAFF SUPPORT TO SPECIAL INDUSTRY COMMITTEES

INPO provides support to specially formed industry committees. Such committees could be established to address specific safety and regulatory issues within a specified time frame or to take an industry position on broader-based industry or regulatory issues. Examples of such committees are the Nuclear Utility Management and Human Resources Committee (NUMARC) or a specific Nuclear Utility Task Action Committee (NUTAC).

6.

INPO's Role—Relationships with Members, Participants, and Other Organizations

In carrying out its dual role of evaluation and assistance, INPO depends on the support of its members and participants and the cooperation of federal agencies, particularly the Nuclear Regulatory Commission (NRC).

To ensure credibility with its members and with the Federal Government, INPO must maintain its independence with respect to any individual member and with respect to government agencies. At the same time, INPO must be responsive to the collective needs of the nuclear utilities and to requests for assistance by its members. INPO also coordinates its activities with other industry and government organizations.

The following principles and assumptions provide for coordination, support, and implementation of INPO programs:

- Member utilities are expected to strive to meet INPO performance objectives and criteria. INPO ensures that appropriate Industry Review Groups (IRGs) are provided an opportunity to review and comment on all performance objectives and criteria.
- Member utilities are expected to be responsive to INPO recommendations made in conjunction with evaluation, accreditation, and events analysis programs.
- Member utilities are expected to achieve and maintain accreditation of their training programs for personnel who operate, maintain, and support their nuclear plants.
- INPO is expected by its members to follow up on evaluation report recommendations, Significant Operating Experience Report recommendations, and accreditation recommendations to see that corrective actions are implemented.
- A special procedure, approved by the INPO Board of Directors, provides guidance in the event that a member utility is not responsive to INPO programs or is unwilling to take action to resolve a significant safety issue. The procedure calls for INPO and the utility management to work to resolve any issues in contention. Should resolution not be satisfactory, the procedure calls for specific interaction between the chief executive officer of INPO and the chief executive officer of the utility. Ultimately, the procedure gives INPO the authority to suspend the utility from membership if the utility continues to be unresponsive.
- INPO members who are members of Nuclear Electric Insurance Limited (NEIL) have authorized and instructed INPO to provide NEIL copies of INPO evaluation reports and other data. NEIL reviews these reports for items that could affect the insurability of its members.

- INPO performance objectives and criteria and recommendations are written without regard to constraints or agreements an individual member may have. Because the performance objectives and criteria and recommendations involve reactor safety and public health and safety, each member utility is expected to resolve any impediments to their implementation that may be imposed by outside organizations, such as bargaining units.
- INPO members and participants limit their requests for assistance from INPO to areas or activities that are within the scope of this plan.
- INPO does not become involved in or conduct assistance visits when a member is confronted with a specific regulatory issue. This could result in INPO involvement in legal or enforcement proceedings and could impact its independent status.
- INPO does not become involved in public or media activities on behalf of the industry or in the role of promoting the nuclear power option. Such involvement would undermine INPO's credibility and objectivity.

To coordinate its activities and best serve its members and participants, INPO maintains liaison with industry organizations such as the Atomic Industrial Forum (AIF), American Nuclear Energy Council (ANEC), American Nuclear Society (ANS), American Public Power Association (APPA), The U.S. Committee for Energy Awareness (USCEA), Edison Electric Institute (EEI), Electric Power Research Institute (EPRI), National Rural Electric Cooperative Association (NRECA), the Nuclear Utility Management and Human Resources Committee (NUMARC), and the Utility Nuclear Power Oversight Committee (UNPOC).

To minimize duplication of efforts and to support its members, INPO maintains liaison with insurer groups such as American Nuclear Insurers, Nuclear Mutual Limited, Nuclear Electric Insurance Limited, and Mutual Atomic Energy Reinsurance Pool.

Coordination of INPO activities with the Nuclear Regulatory Commission is described in Appendix B. INPO coordinates its activities with other agencies of the Federal Government as appropriate. For example, certain aspects of the International Participant Program are coordinated with the Department of State. INPO also has a formal Participation Agreement with the Department of Energy (DOE).

APPENDIXES SECTION

Appendix A
Description of Major INPO Programs A-1

Appendix B
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Appendix A

Description of Major INPO Programs

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1. Evaluation Programs

1.1 OPERATING PLANT EVALUATIONS

INPO conducts periodic evaluations to promote the highest levels of excellence in the operation, maintenance, and support of operating nuclear plants. Teams of qualified and experienced INPO personnel conduct these evaluations to assess the knowledge and performance of station personnel; the condition of systems and equipment; the quality of programs and procedures; and the effectiveness of station management, with focus on plant safety and reliability. The evaluation teams are augmented by senior reactor operators from operating units similar to those at the station being evaluated. The following areas are covered: organization and administration, operations, maintenance, technical support, training, radiological protection, chemistry, and emergency preparedness. Performance of station personnel during simulator training sessions also is observed. Evaluations are performance-oriented and are based on performance objectives and criteria developed by INPO and reviewed by the industry. Evaluations of each operating nuclear station are conducted at an average interval of about 15 months.

Formal reports of findings and recommendations for improvement are provided to the utility. Utility responses to INPO recommendations, with commitments to improved performance, are included in the final report. INPO follows up in subsequent evaluations and visits to assess achievement of the recommended improvements.

Copies of the final plant evaluation report are distributed according to a release policy approved by INPO's Board of Directors.

1.2 CONSTRUCTION PROJECT EVALUATIONS

INPO conducts periodic evaluations of construction projects to promote the highest quality in design control and construction activities, including the transition to start-up and testing activities.

Evaluations of construction projects are conducted approximately every 18 months until the projects enter the near-term operating license (NTOL) phase. These evaluations are based on INPO-developed performance objectives and criteria. The evaluations consist of project-related activities at the construction site, utility corporate headquarters, and locations of major design activities, such as the architect-engineer and nuclear steam supply system design offices. Teams of qualified and experienced INPO personnel, both permanent and on loan from member utilities and supplier participants, conduct these evaluations. The following areas are covered: organization and administration, design control, construction control, project support, training, quality, and test control.

A substantial number of INPO's construction project evaluation personnel are on loan from member utilities and supplier participants.

Copies of the final evaluation report are distributed according to a release policy approved by INPO's Board of Directors.

1.3 CORPORATE EVALUATIONS

INPO conducts evaluations of utility corporate organizations to promote improvements in corporate support of operating nuclear stations. Teams of experienced personnel conduct these evaluations to assess quality of programs and procedures and effectiveness of corporate management, focusing on issues relating to nuclear station safety and reliability. The following areas are covered:

- organization and administration
- operations support
- maintenance support
- technical support
- design engineering support
- materials management
- training and qualification
- human resources management
- radiological protection
- chemistry
- industrial safety
- licensing and regulatory requirements
- nuclear safety and quality programs
- emergency preparedness
- documentation management

Evaluations are as performance-oriented as practicable and are based on performance objectives and criteria developed by INPO, with industry review.

Corporate evaluations normally are scheduled in conjunction with and complementary to an evaluation of a utility's nuclear station. For utilities with construction projects, but no operating units, INPO conducts a corporate assist visit in conjunction with the near-term operating license (NTOL) assist visit as the utility prepares to operate its plant.

Insofar as practical, the findings and/or recommendations identified during the corporate phase of the evaluation are included in the evaluation report for the operating station. INPO recognizes that some findings or recommendations related to corporate support should not be included in the station report. Findings and recommendations of this nature are provided separately from station evaluation reports. The utility is expected, however, to respond to these findings and recommendations, and INPO follows up on them in subsequent corporate and station visits or evaluations.

2. Accreditation and Training Programs

2.1 PERFORMANCE-BASED TRAINING SYSTEM DEVELOPMENT

INPO provides assistance to members in establishing and maintaining performance-based training and qualification programs to help ensure that personnel have the knowledge and skills required for performance of their jobs. INPO provides guidance and assistance to utilities on the training system development (TSD) process used to develop performance-based programs.

The Institute coordinates industrywide job analysis and task analysis efforts and makes the resulting data available to all members and participants. INPO also assists members in conducting plant-specific job analyses and task analyses, which include providing plant-specific data in the central computerized data base for use by all utilities.

In evaluating and accrediting industry training, INPO reviews each member utility's progress toward implementing performance-based training.

2.2 ACCREDITATION PROGRAM

INPO manages the accreditation of utility training programs conducted for operations, maintenance, and technical personnel. The accreditation process is designed to identify weaknesses in utility training systems and to assist in making needed improvements. The process includes self-evaluations by member utilities, with assistance provided by INPO staff; on-site evaluations by a team of INPO and utility personnel; and the award (or deferral) of accreditation by the Accrediting Board. Member utilities are expected to seek accreditation of the following training programs:

- non-licensed operator training
- reactor operator training
- senior reactor operator/shift supervisor training
- shift technical advisor training
- instrument and control technician training
- electrical maintenance personnel training
- mechanical maintenance personnel training
- chemistry technician training
- radiological protection technician training
- technical training for technical staff and managers

Members may apply for accreditation in phases during the first round of accreditation evaluations (until all programs are accredited for the first time). All members with a plant in operation by the end of 1984 are expected to apply for accreditation of all programs by the end of 1986. Other members are expected to apply for accreditation of all programs within two years after fuel load.

During the first round, the process and procedures will be refined. After the first round is completed, half or more of all programs at a site will be examined for accreditation renewal at the same time. Each member utility will be expected to apply for accreditation renewal of all programs once every four years.

2.3 TRAINING AND QUALIFICATION GUIDELINES

INPO develops and distributes training and qualification guidelines for operations, maintenance, and support personnel. These guidelines are designed to assist the utility training organization in developing quality training programs.

Training and qualification guidelines are revised and updated periodically to incorporate changes identified through job analyses and task analyses and to take into account lessons learned in other INPO programs, such as evaluations, accreditation, events analysis, and workshops.

INPO training and qualification guidelines provide a sound basis for utility training programs.

2.4 STANDARDIZED GENERAL EMPLOYEE TRAINING IN RADIOLOGICAL PROTECTION PROGRAM

INPO sponsors a standardized general employee training in generic radiological protection (GET-RP) program. In this program, members certify that their training meets the intent of INPO general employee training (GET) guidelines. INPO provides standard generic radiological protection examinations and assists members by reviewing GET programs on site and providing recommendations for improvement. Through participation in this program, member utilities can eliminate redundant radiological protection training by recognizing training provided by other organizations. The standardized examination can be given to a person who has had GET-RP training at a participant's organization, in lieu of repeating the GET-RP training.

3. Events Analysis and Information Exchange Programs

3.1 EVENTS ANALYSIS PROGRAM

INPO reviews and analyzes operating and construction experiences and events from both domestic and non-U.S. nuclear plants. The program is designed to provide in-depth analysis of nuclear operating experience and to apply the lessons learned within the industry. Events are screened for significance, and those with generic applicability are disseminated to the industry in one or more of the following forms:

- Significant Operating Experience Reports (SOERs)
- Significant Event Reports (SERs)
- Operations and Maintenance Reminders (O&MRs)
- INPO special reports
- Workshop and seminar presentations

The Institute also conducts detailed field investigations of selected significant events to determine root causes and develop recommendations to help prevent recurrence.

Member utilities are expected to support the events analysis program by providing INPO with detailed and timely operating experience information. INPO member utilities are expected to evaluate and take appropriate action on recommendations provided in SOERs and SERs. During its periodic evaluations, INPO follows up on each utility's action in response to these recommendations.

3.2 NUCLEAR PLANT RELIABILITY DATA SYSTEM

INPO operates and manages the Nuclear Plant Reliability Data System (NPRDS). NPRDS supplies data on the performance of important nuclear plant systems and components. INPO member utilities are expected to report design characteristics and performance data on the systems and components covered by NPRDS to a computerized data base maintained by the Institute. INPO and member utilities use the data to solve plant problems and improve plant safety and reliability. NPRDS failure reports are tracked and analyzed as part of the events analysis program.

3.3 NUCLEAR NETWORK SYSTEM

NUCLEAR NETWORK is an international electronic messaging system for the exchange of nuclear plant information. It is the major communication link for the Significant Event Evaluation and Information Network (SEE-IN). Significant events, Significant Event Reports (SERs), and operations and maintenance information are transmitted by the system. It also provides the vehicle for "round table" questions and other correspondence among INPO members and participants.

The system includes a special, dedicated channel for reporting plant emergency situations. This feature allows the affected utility to simultaneously provide U.S. industry and INPO's international and supplier participants with timely information. All NETWORK users can receive updates simultaneously.

3.4 PERFORMANCE DATA COLLECTION AND TRENDING

INPO collects and analyzes data and information related to nuclear station performance. To minimize the burden on members, INPO makes maximum use of reports submitted by utilities to the NRC and others. Additional data is collected during evaluations, and periodically, requests may be made of member utilities for selected data.

Industrywide and plant data, plus trends developed from the data, are provided to member utilities for a number of key operating plant performance indicators. Member utilities use this data in setting specific performance goals for their plants, as well as in assessing and improving performance of their nuclear plants. In selected areas, INPO uses the data to set industrywide performance goals.

3.5 LICENSEE EVENT REPORT AND NRC DATA BASES

INPO maintains a complete Licensee Event Report (LER) data base on its computers, with supplementary information on microfilm. This data base is designed primarily to support INPO SEE-IN Program activities and related efforts by members and participants. LERs are received by INPO directly from the utilities and entered into the data base. The data base is used for initial LER screening, as well as for trending of plant events.

INPO also maintains an index of the public portion of the NRC document data base on its computers, with the actual records available at the Institute on microfiche. Updated index computer tapes and microfiche are received monthly from the NRC.

INPO members and participants are provided dial-in access to this data base index. INPO also conducts searches of this data base for its members and participants on request.

4. Assistance Programs

4.1 SPECIAL ASSISTANCE VISITS

INPO conducts special assistance visits to member utilities and international participants as requested and agreed to by the Institute. These visits provide assistance in specific areas identified by the requesting organization and are in areas in which INPO has experience or expertise. Special assistance visits are conducted by qualified INPO personnel, including permanent staff and on-loan personnel. To supplement its resources, INPO also calls on qualified personnel from member utilities to augment its assistance teams.

Written reports that provide the results of special assistance visits are provided only to the requesting utility.

4.2 NEAR-TERM OPERATING LICENSE PLANT ASSISTANCE VISITS

INPO conducts assistance visits to near-term operating license (NTOL) plants to help in preparation for operation and to promote operational excellence. Through these visits, INPO attempts to provide the NTOL plant staff with the full benefit of INPO's experience in evaluating operating plants. Teams of experienced INPO personnel, augmented with senior reactor operators from a similar operating plant, conduct the assistance visits. The team assesses the plant's readiness for operation, as reflected in the knowledge and performance of station personnel; the condition of systems and equipment; the quality and completeness of programs and procedures; and the effectiveness of station management, with a focus on plant safety and reliability. The following areas are covered: organization and administration, operations, maintenance, technical support, training, radiological protection, chemistry, and emergency preparedness. Observations of station personnel performance during simulator training sessions are included. INPO assistance visits are performance-oriented and are based on performance objectives and criteria developed by INPO, with industry review.

For utilities that have no operating units, a corporate assistance visit is conducted in conjunction with the NTOL assistance visit.

INPO provides recommendations for improvement to utility management in a letter report. While a response to the recommendations is not requested, INPO does follow up on its recommendations during the first regular operating plant evaluation after the NTOL visit.

NTOL assistance visits are scheduled after the plant is more than 85 percent complete and at an appropriate time in the NTOL phase (typically six to 12 months prior to fuel load). Follow-on assistance visits may be scheduled for an NTOL plant under special circumstances, such as a delay in fuel load.

4.3 GOOD PRACTICE DEVELOPMENT

INPO develops good practice documents covering selected areas of plant construction, operation, maintenance, and support, based on proven methods or best practices found in the industry. Typically, elements of a good practice are collected at a number of utilities and are synthesized into a good practice document by the INPO staff, with industry review.

In general, good practice documents define one method of meeting INPO performance objectives and criteria. Their use by member utilities is optional, in recognition of the fact that other approaches also can be equally effective in achieving good performance.

4.4 EMERGENCY PREPAREDNESS PROGRAM

INPO promotes a high degree of readiness throughout the industry to minimize the consequences of a nuclear emergency. Assistance is provided to member utilities in developing and maintaining effective utility emergency response programs. Additionally, the Institute will assist nuclear utilities in mobilizing the resources of the nuclear industry to meet the needs of an emergency.

A key results-oriented program in this area is the routine observation of utilities in emergency preparedness drills or exercises by small INPO teams.

4.5 RADIOLOGICAL PROTECTION PROGRAM

INPO assists members in minimizing individual and collective occupational radiation exposure and in controlling the spread or release of radioactivity associated with nuclear power plant operations.

The Institute promotes excellence in radiological protection through several programs, including evaluations, assistance visits, training accreditation, development of criteria, guidelines and other documents, and the previously mentioned General Employee Training in Radiological Protection Program.

4.6 CHEMISTRY PROGRAM

INPO provides assistance to member utilities in developing and maintaining an effective chemistry program.

Member chemistry programs are reviewed. The Institute promotes excellence in chemistry through several programs, including evaluations, assistance visits, technical exchanges, training, and workshops.

4.7 HUMAN RESOURCES MANAGEMENT

INPO undertakes projects designed to assist member utilities in their manpower planning and other human resource management activities. Status and trends are monitored in utility nuclear-related employment, including shortages, manpower losses, and projected growth, by conducting surveys of all member utilities. The results of these surveys are provided to member utilities for their use in manpower planning.

Recommendations are developed for personnel selection and human resource management functions that reflect good practices found in the industry. As part of the corporate evaluation program utilities' human resource management activities that impact their nuclear organization are reviewed.

The Institute manages an industry educational assistance program to provide undergraduate scholarships and graduate fellowships for students majoring in nuclear or nuclear-related engineering or power generation health physics programs. These students are encouraged to pursue careers in the nuclear utility industry. By the end of 1984, 759 scholarships and 223 fellowships had been awarded.

4.8 INTERNATIONAL TECHNICAL EXCHANGE VISITS

In addition to special assistance visits in specific areas that are requested by international participants, INPO conducts technical exchange visits to participants' facilities. These team visits have the dual purpose of identifying good practices at international plants and noting areas in which recommendations for improvement can be offered. Technical exchange visit teams can be augmented, on an invitational basis, with experts provided by other international participants to further enhance the mutual benefits of the international technical exchange.

4.9 WORKSHOPS

INPO sponsors workshops in specific technical areas to provide forums for information exchange between INPO and various levels of utility and participant management. This information exchange provides an opportunity to share industry lessons learned and obtain industry feedback on INPO programs and activities. INPO-sponsored workshops also allow individuals from member utilities to meet and exchange information with their counterparts at other utilities.

Appendix B

INPO Relationship with NRC

The nuclear utility industry in the United States, like other industries that impact the health and safety of the general public, is regulated by the Federal Government. This regulatory function is based on the Atomic Energy Act of 1954, as amended, and is carried out by the U.S. Nuclear Regulatory Commission (NRC). How the NRC carries out its responsibilities in regulating the nuclear industry has undergone substantial change since the Three Mile Island (TMI) accident. This change, which is still evolving, has tended to broaden NRC's role.

INPO was not created to supplant the regulatory role of the NRC, but to provide the means whereby the industry itself could, acting collectively, make its nuclear operations safer. It was envisioned that peer reviews and criteria based on excellence would be effective in bringing about improvements. In the broad sense, the ultimate goals of the NRC and INPO are the same in that both strive to protect the public. How these goals are achieved is necessarily different. It was recognized that in establishing and meeting its goals and objectives, INPO would have to work closely with the NRC, while at the same time not becoming or appearing to become either an extension of the NRC or an advocacy agent of the utilities.

The conduct of evaluations is one of the most important functions performed by INPO. It is also a function that puts INPO closest to the role of being a regulator. The NRC issues regulations and is required to determine utility compliance with regulatory requirements. INPO issues criteria and conducts evaluations to determine how well the criteria are being met. While these two may appear very similar, there are significant differences. There are two basic differences between NRC regulations and INPO criteria. An NRC regulation is a condition or specification that must be met in order to obtain or retain a license. INPO criteria generally establish goals that provide broad statements of conditions. Regulations normally should not be subjective, whereas INPO criteria usually are.

Another difference relates to the purpose of the evaluation in contrast to a regulatory inspection. The former stresses assistance in achieving a given goal, whereas the latter stresses compliance to a requirement. Both are considered necessary.

It is because of these differences that INPO and its members conclude there should be a clear separation between INPO evaluations and NRC inspections. It is intended that the NRC will take cognizance of INPO evaluations. It is anticipated that NRC will make its determination of credit due the industry by reviewing the INPO process and programs and not through the monitoring of INPO's interactions with its individual members.

Entanglement of NRC activities and INPO programs diverts INPO and NRC from their respective missions. Industry expects NRC and INPO activities to be independent, yet complementary. INPO's effectiveness would be seriously undermined if an NRC regulatory document incorporated, or in effect codified, INPO programs, documents, or criteria.

This appendix sets forth the principles necessary for INPO to support the industry within the existing regulatory framework.

In concept, the industry expects INPO to keep the NRC apprised of its generic activities, while INPO's interactions with an individual member are between that member and INPO (except where reportable occurrences are encountered, as discussed below).

INPO recognizes the need for NRC to assess the quality of INPO's products and the success of its programs. NRC has independent and diverse methods to assess industry progress or results that might be derived in part from INPO programs. In addition, INPO expects to meet its obligations in this regard and to obtain recognition for industry's self-improvement and self-regulation efforts by providing NRC information on INPO programs and activities, including the following:

- copies of selected generic documents
- access to other pertinent information as described in specific coordination plans
- periodic briefings
- with agreement from member utilities, observation of certain INPO field activities by NRC employees

INPO will encourage member utilities to make copies of operating plant evaluation reports available to the NRC for review at each utility or site and to provide NRC copies of construction project evaluation reports.

On the other hand, the industry expects NRC to recognize that audits of INPO activities or records are the responsibility of INPO's president and INPO's Board of Directors. Reviews or audits of INPO's technical activities normally are carried out by the Industry Review Groups. In view of this, while the industry expects and welcomes INPO exchange of information with NRC and NRC review of INPO products and programs, the industry expects NRC to refrain from formal audits or inspections of INPO by the NRC staff or a contracted third party. In support of these efforts, NRC and INPO have entered into a Memorandum of Agreement that includes coordination plans covering areas of mutual interest.

The following specific principles and assumptions supplement those listed in Section 6 of the Institutional Plan:

- INPO criteria and recommendations are based on best practices and industry's commitment to excellence, not on regulatory requirements. In addition, INPO follows up to ensure utilities are responsive to INPO recommendations. As a consequence, utilities should not have to answer to NRC concerning INPO findings and recommendations, except as noted below.

- INPO has implemented a policy and appropriate procedures with regard to handling of items that are potentially reportable to the NRC. INPO's policy is to inform appropriate utility management of such items during the normal course of business so that the utility may evaluate and report the item as appropriate. If INPO becomes aware of a defect or failure to comply that requires a report under 10 CFR 21, INPO has an obligation to ensure that the item is reported.

- INPO conducts certain private transactions with its members. For example, when a member recognizes it is experiencing difficulty in an area where INPO has expertise, INPO encourages that member to request a special assistance visit. NRC participation in or requests for copies of correspondence concerning such visits could be a deterrent to future requests for these visits. Similarly, the exit meetings following INPO evaluations are more productive if there is open exchange of information between the INPO team and the utility. NRC presence in these meetings may be a deterrent to constructive dialog.

- The industry expects that NRC will not utilize the routine proceedings between INPO and its members as a basis for actions against INPO's members. Both INPO and its members feel it would be counterproductive for the NRC to use information derived from routine INPO proceedings with its members to determine the level or degree of punitive actions it might levy against a member.

Appendix C

INPO Founding Groups

The following committees and advisory groups were involved in the original development of the Institute of Nuclear Power Operations in 1979.

TMI Ad Hoc Nuclear Oversight Committee

(Senior industry committee)

Floyd L. Lewis, Chairman
Middle South Utilities, Inc.

Thomas G. Ayers
Commonwealth Edison Co.

James L. Everett
Philadelphia Electric Co.

William S. Lee
Duke Power Co.

Frank Linder
Dairyland Power Cooperative

A. J. Pfister
Salt River Project

John D. Selby
Consumers Power Co.

Frank M. Warren
Portland General Electric Co.

INPO Steering Committee

(Overseeing establishment of INPO; reported to Oversight Committee)

William S. Lee, Chairman
Duke Power Co.

A. J. Pfister, Vice Chairman
Salt River Project

Howard P. Braun
Pacific Gas and Electric Co.

Sol Burstein
Wisconsin Electric Power Co.

Richard M. Eckert
Public Service Electric and Gas Co.

Byron Lee Jr.
Commonwealth Edison Co.

Frank M. Staszesky
Boston Edison Co.

James Taylor
Dairyland Power Cooperative

INPO Establishment Advisory Group

To advise on the original functions and organization of INPO, Dr. Chauncey Starr assembled a group of experienced people from various activities with strong national safety programs or who had participated in major educational activities related to safety.

Dr. S. A. Bernsen and
Frank M. Staszesky Jr.
Bechtel Power Corp.

Dr. Joseph J. Bulmer
President, Hudson Valley Community College (formerly in charge of the Naval Nuclear Power Engineering School at the Knolls Atomic Power Laboratory)

Leo Duffey
EG&G Idaho, Inc. (formerly with Bettis Atomic Power Laboratory)

Jerome Lederer
Retired (formerly Director of Safety, NASA, and Director, Flight Safety Foundation)

Dr. Miles Leverett
Retired (formerly with General Electric Co.)

Dr. Russell O'Neill
Dean, School of Engineering and Applied Science, University of California at Los Angeles

Walker Rapp
Pacific Gas and Electric Co.

Fred P. Riley
Southern California Edison Co.

AIF Policy Committee on Follow-up to TMI Accident

(Recommended establishment of INPO; reported to Oversight Committee)

Byron Lee Jr., Chairman
Commonwealth Edison Co.

Robert A. Szalay, Secretary
Atomic Industrial Forum

Shepard Bartnoff
Jersey Central Power & Light Co.

Vincent S. Boyer
Philadelphia Electric Co.

A. Phillip Bray
General Electric Co.

Robert Cockrell
Washington Public Power Supply System

Joseph R. Dietrich
Combustion Engineering, Inc.

Roy H. Dunham
Tennessee Valley Authority

Richard M. Eckert
Public Service Electric and Gas Co.

Walt F. Fee
Northeast Utilities

D. Clark Gibbs
Middle South Services, Inc.

John W. Gore Jr.
Baltimore Gas and Electric Co.

Steve H. Howell
Consumers Power Co.

William J. L. Kennedy
Stone & Webster Engineering Corp.

Leonard J. Koch
Illinois Power Co.

William J. Lindblad
Portland General Electric Co.

John H. MacMillan
Babcock & Wilcox Co.

Warren H. Owen
Duke Power Co.

Romano Salvatori
Westinghouse Electric Corp.

Charles W. Sanford
Bechtel Power Corp.

James R. Stoudt
Gilbert/Commonwealth, Inc.

Ruble A. Thomas
Southern Company Services, Inc.

Donald E. Vandenburgh
Yankee Atomic Electric Co.

William Wallace III
Ebasco Services, Inc.

John Ward
Sargent & Lundy

REPORT ON BACKFITTING AND LICENSING PRACTICES
AT THE U. S. NUCLEAR REGULATORY COMMISSION

James R. Tourtellotte, Chairman
Regulatory Reform Task Force
U. S. Nuclear Regulatory Commission
March 11, 1985

REPORT ON BACKFITTING PRACTICES
AT THE U. S. NUCLEAR REGULATORY COMMISSION

Introduction

In a letter of December 11, 1984, directed to Chairman Nunzio J. Palladino, United States Nuclear Regulatory Commission, the Honorable Carlos J. Moorhead, Ranking Minority Member, Subcommittee on Energy, Conservation, and Power, and the Honorable James T. Broyhill, Ranking Minority Member, Committee on Energy and Commerce, of the United States House of Representatives, requested a report on backfitting and licensing practices at the NRC. More specifically, paragraph 2 of that letter states:

> Last August, Mr. James Tourtellotte, Chairman of the Commission's Regulatory Reform Task Force, reported that there were serious problems with the Staff's current backfit practices. To facilitate our review of the proposed regulation, we would appreciate being more fully apprised of the concerns raised by Mr. Tourtellotte's memorandum. We would greatly appreciate your direction to Mr. Tourtellotte to summarize in writing the results of his review of past and current NRC licensing and backfit practices. We are particularly interested in learning whether the problems he identified with respect to Duquesne Light are specific to this utility or are of more generic import.

The short answer is that the Duquesne case is of more generic import as the following report suggests. Before addressing merits of that case, however, a brief review of the history of backfitting is in order.

The Commission's current rule on backfitting is contained in 10 CFR § 50.109, which reads as follows:

> (a) The Commission may, in accordance with the procedures specified in this chapter, require the backfitting of a facility if it finds that such action will provide substantial, additional protection which is required for the public health and safety or the common defense and security. As used in this section, "backfitting" of a production or utilization facility means the addition, elimination, or

> modification of structures, systems or components of the facility after the construction permit has been issued.
>
> (b) Nothing in this section shall be deemed to relieve a holder of a construction permit or a license from compliance with the rules, regulations, or orders of the Commission.
>
> (c) The Commission may at any time require a holder of a construction permit or a license to submit such information concerning the addition or proposed addition, the elimination or proposed elimination, or the modification or proposed modification of structures, systems or components of a facility as it deems appropriate.

The primary purpose of the rule when it was passed on March 31, 1970, was to improve the stability of the licensing process by minimizing the alterations of structures, systems or components of a nuclear power plant after the construction permit had been issued. The rule has been selectively ignored by the staff for nearly 15 years. There is a substantial amount of evidence suggesting that the staff's backfitting practices which have cost consumers billions of dollars have made nuclear plants more difficult to operate and maintain, have injected uncertainty and paralyzing delay into the administrative process and in some instances may have reduced rather than enhanced public health and safety.

Because public health and safety is a primary concern to the Nuclear Regulatory Commission pursuant to the Atomic Energy Act, it is important to understand how undisciplined backfitting may have created plants which are not as safe as they might otherwise have been. In terms of simple logic, alteration of the systems, structures or components of a nuclear power plant may have: (1) a positive effect on safety; (2) a neutral effect on safety; or (3) a negative effect on safety. The problem with undisciplined backfitting is that a new requirement may be made for a nuclear power plant without the appropriate analysis necessary to establish either the need or the effects of modification. Lacking adequate analysis, the question of whether the effects on the plant are positive, neutral or negative is left unanswered. It may be of no safety concern if upon analysis the modification turned out to be positive. It may be of little more than economic concern if it turned out to be neutral. It would be totally unacceptable, however, if the backfit rendered the nuclear power plant less safe than it was before.

There are additional reasons for concern over sufficiency of analyses in backfitting. Changes to systems, structures or components in an undisciplined way can have several specific effects on a power plant. They can lead to less than optimal design arrangements, may compel personnel to constantly face the uncertainties associated with change and perpetual retraining, and may sometimes require a high level of construction creating a distraction and, therefore, a negative effect on operation. Furthermore, backfits may result in more frequent shutdowns and start ups, thereby increasing exposure to component failure and operator mistakes. Insufficient analysis also leaves the door open to the effective cancellation of other safety features by reason of system interactions under accident conditions.

To correct the backfitting problems, the Commission has proposed a revision to its rules at 49 Federal Register 47034 (November 30, 1984). Proposed § 50.109(a) requires as a condition precedent to the imposition of a backfit: (1) a "systematic and documented analysis" of certain factors listed in paragraph (d); (2) the analysis must demonstrate that the backfit will substantially increase the overall protection of the public health and safety or the common defense and security; and (3) that the direct and indirect cost of implementation for that facility are justified in view of the increased protection. Section 50.109(a) also has an emergency exception which provides that the analysis need not be performed, however, if the Commission determines that absent immediate action to impose the backfit, the public health and safety or the common defense and security will not be adequately protected. Analysis will ultimately be required, however, as the rule further provides: Imposition of the backfit in this circumstance shall not relieve the Commission of documenting the analysis after the fact.

The standard against which proposed backfits would be measured is "substantial increase in the overall protection of the public health and safety or the common defense and security." Substantial means important or significant in a large amount, extent, or degree. Under such a standard, the Commission would not ordinarily expect that safety improvements would be required as backfits which result in an insignificant or small benefit to public health and safety or the common defense and security, regardless of the implementation costs. On the other hand, the standard is not intended to be interpreted in a manner that would result in disapprovals or worthwhile safety or security improvements having costs that are justified in view of the increased protection that would be provided.

The phrase "overall protection of the public health and safety or the common defense and security" in the proposed backfit standard also deserves some discussion. The principal purpose of requiring consideration of the overall protection that would be provided by a proposed backfit is to assure that both its negative and positive effects are taken into account in deciding whether the backfit is justified. A backfit for a part of a plant should be evaluated in light of the net increase in overall protection that the entire plant would provide as a result of the backfit, taking into account the effects it would have on other aspects of the plant. Thus, the net benefit of a backfit to the protection provided by the plant as a whole is the overriding consideration, not the benefit just to the part of the plant being backfitted.

However, the Commission does not intend use of the phrase "overall protection" in the backfit standard to signal a departure from its traditional reliance on defense in depth for protection of public health and safety. Therefore, safety improvements in one line of defense against undue risk should not be disapproved or approved based solely on the presence or absence of another line of defense to cope with the failure of the first. For example, safety improvements in the integrity of the reactor coolant system should not be dismissed merely because an emergency core cooling system has been provided to protect public health and safety with high confidence in the event that the integrity of the reactor coolant system is lost. On the other hand, such a suggested improvement may be precluded because it does not meet the substantial test, or does not increase overall protection provided by the plant due to, for example, the negative impacts on other aspects of the plant.

Staff analysis of a backfitting requirement as a condition precedent to imposition of that requirement is the heart of the reform effort. It is important to note that the new proposed rule does not prohibit the imposition of needed backfits by the staff. Rather, it prohibits the staff from imposing a requirement for a backfit without previous analysis in terms of its safety significance and its basis in the regulations. Those engaged in the backfit debate appear to sometimes lose sight of this very important distinction.

In general, backfitting is a process that involves well-intentioned and competent individual reviewers attempting to make microscopic incremental improvements to the safety of the plant. They do this by attempting to improve the safety contribution of an individual system or component. This is done, however, without the benefit of integrating the impact of these changes across the whole system or plant. The management failure here is allowing these reviewers to require changes and enhancements beyond the regulatory requirements. Management must be involved in ensuring that deviations from regulatory requirements either by the licensee or the reviewer are minimized to avoid unreviewed system interactions and net losses in overall plant safety.

This report is based upon an investigation of the licensing activity at Beaver Valley 2 by Duquesne Light, conversations with industry and government officials, and upon the author's insights gained through 11 years experience in the nuclear licensing process. It is only a summary and is not intended to be definitive on the NRC backfitting problem. It, however, may assist the reader in identifying and understanding issues. The views expressed in the report are those of the author and do not necessarily reflect the views of the Nuclear Regulatory Commission.

The management of Duquesne Light should be commended for its extraordinary courage in insisting upon its rights and for protecting its ratepayers. Many companies have waived their rights because of intimidation and fear of retaliation by regulators. The management of Duquesne and, in particular, their Manager of Regulatory Affairs are performing a real service for all those interested in achieving a safe but balanced regulatory process.

This report discusses the facts of the backfitting appeal as lodged by Duquesne Light in the Beaver Valley 2 licensing case, interprets some of those experiences in light of the overall backfitting practices[1] of the NRC discusses related problems in the licensing process and makes recommendations. Focus is primarily on key factors in the backfit problem. Those are: undisciplined approach, inadequate analysis, confusion over what is or is not a legal regulatory requirement and general fairness.

Appeal of Beaver Valley

In August of 1984, it was brought to my attention that between May 30 and June 25, 1984, Duquesne Light had filed eight objections to what they perceived to be backfits. None of the Duquesne letters had been answered by the staff as of August 28, 1984 when I wrote a memorandum to the Commission advising them of the situation. Although NRR issued a monthly status report on backfitting, none of Duquesne's requests appeared in the

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[1] Backfitting in the field by Regional Offices and by Inspection and Enforcement is not touched upon in this report.

June or July reports on backfitting and the mention was only in the form of a footnote in the August report. I brought this matter to the Commission's attention because, in my view, there was a serious disparity between what the staff represented it would do and what it was doing. I pointed out in the memo that through staff inaction, the licensee is drawn inexorably toward Safety Evaluation Report (SER)[2] and licensing dates with major items open and undiscussed. I also pointed out the staff was fully aware that this is a way to create leverage, putting the licensee in a position where due to the press of time it is forced to accept the position of the staff, regardless of the merit of the staff position.

On September 5 at a Commission meeting, the Deputy Director of NRR suggested that my memorandum of August 28 did not accurately reflect the facts. He stated that there were four or five meetings between the time the Duquesne letters had been filed and the date of my memorandum and that the backfitting issues had been discussed. The Commission requires that minutes of such meetings be kept and filed. There are no minutes of any such meetings being held and Duquesne states that no such meetings were held. Therefore, the evidence strongly suggests that the Deputy Director of NRR was inaccurate in his assessment of the facts and representations to the Commission.

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[2] The Safety Evaluation Report is a staff document evaluating the safety of an applicant's plant as viewed through applicant's safety analysis report and staff/applicant interactions. It must be substantially completed before operation can begin.

After my memorandum of August 28, the Branch Chief in charge of Beaver Valley in the Division of Licensing called for a meeting between the staff and Duquesne on September 26, 1984. He stated that the meeting was to be held pursuant to Generic Letter 84-08,[3] a letter issued April 4, 1984 by the Director of Licensing which states, "The plan for managing plant specific backfitting for OL applicants and CP holders will follow the procedures for operating reactors until final procedures are developed."

At the meeting on September 26, the Assistant Director in charge of the Beaver Valley case opened the meeting by saying that Duquesne should state its case for the appeal. Duquesne responded by saying that it was difficult for them to know exactly what to say during the meeting, because the requirements of Generic Letter 84-08 had not been met by the staff and therefore, they did not know exactly what the staff's position was. The Assistant Director responded that he was not familiar with Generic Letter 84-08, even though he recalled having read it, but that the meeting was being held as a regular licensing appeal meeting and not pursuant to Generic Letter 84-08. In the circumstances, the Assistant Director suggested that the meeting continue as a mock appeal meeting so that Duquesene could get an idea of what the staff would require at some future meeting to be held. An appeal meeting was then scheduled for October 5, 1984.

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[3] While the current revised backfitting rule was only in proposal format, the Commission had previously directed the staff to develop interim procedures to control backfits at operating reactors. In response to the Commission directive, Generic Letter 84-08 was issued by the Director, Division of Licensing on April 5, 1984, informing the industry of those interim procedures.

Shortly before the October 5 meeting, the Director of Licensing cancelled the appeal meeting and instead held a meeting with the major management of Duquesne to discuss the general disposition of the case. At that meeting, the Director of Licensing suggested that Duquesne summarize the backfit objections it had previously raised. Simultaneously, he directed his Assistant Director to prepare a response to the issues raised by Duquesne, the response to be in a form required by Generic Letter 84-08.

It is interesting to note at this juncture that the same staff member who wrote the letter calling for a meeting pursuant to Generic Letter 84-08 has repeatedly taken the position that 84-08 does not apply in this case because the staff has not declared the items cited by Duquesne to be backfits and in his view there could be no backfits unless the staff actually said they were backfits. A number of conversations reported by Duquesne with the staff suggest that many members of the NRC staff share the view that backfits do not exist unless the NRC staff says they exist. Moreover, some staff members have reportedly stated they would not follow 84-08. As a practical matter, whether backfits exist depends on the facts of a given case, not on staff pronouncements or terminology.

In the response to Duquesne, the NRC staff failed to follow its own procedures and provided information on only 17 of the 36 items the staff is required to address under Generic Letter 84-08 in response to backfit objections. This, once again, left Duquesne in a position of not knowing precisely what the staffs' concern was or how they should respond to that concern. Subsequent correspondence between them led to a further response by the staff in January 1985 which addressed the items of 84-08.

Duquesne filed additional backfit objections. To date six of sixteen items have been officially closed, five have been resolved and five have not been officially closed.

Although I do not wish to discuss item by item the merits of the Duquesne backfit objections, review of two items can help in understanding the backfitting problem. For that purpose I turn to the issues of fire protection and probable maximum precipitation.

Fire Protection

The requirements for fire protection are generally stated in Appendix R to Part 50 of the Commission's regulations. Because of grandfathering, Beaver Valley 2 is not required to meet Appendix R. Nevertheless, the fire protection system which Duquesne designed to meet the requirements of licensing review is essentially the same system as has been approved for other licensees who are subject to Appendix R. The fire suppression system installed in the cable spreading room is a gas suppression system with backup standpipe water and firehose outside the cable spreading room. Calvert Cliffs, which was the first plant to receive approval of its fire protection system under Appendix R, and 13 other operating plants have essentially the same system. In contrast to the staff's apparent acceptance of similar systems at operating or recently licensed plants, the staff seeks to require Beaver Valley 2 to install a fixed sprinkler system in its cable spreading room. There is no requirement for a water sprinkler system in the regulations of the Commission. The staff bases its requirement on a vague reference to water in the Standard Review Plan[4] (SRP), even though the Commission has clearly stated that SRP's are not requirements. This same issue was raised with respect to the Byron plant, and the staff lost that issue on appeal. Byron was licensed recently and also has a gas suppression system. It is also interesting to note that this same issue has been raised separately at several other plants but has not been submitted to the Committee to Review Generic Requirements (CRGR)[5] for generic review.

It should be pointed out that the cable spreading room involves only a small part of the overall fire protection plan. Moreover, because fire protection exists primarily to assure safe shutdown capability and other parts of the system would give that assurance, the use of a gas suppression system would appear to be acceptable. In fact, a blue ribbon panel of fire protection engineers and experts was convened by NRC January 29, 1985 and generally agreed that a gas suppression system provides an acceptable level of fire protection safety for a cable spreading room where alternative safe shutdown capability exists and there is good fire fighting access to the cable spreading room.[6] Nonetheless, select members of the NRC staff persist in making a requirement of that which appears to be neither legally required nor technically necessary to assure safety.

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[4] Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides of the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

[5] CRGR is a staff organization having responsibility for reviewing backfits which may be applied generically to several plants.

Several questions are raised by this case. If a gas suppression system with standpipe water on the outside is safe for 14 operating plants and has been acceptable under Appendix R, why is it not safe and acceptable for a plant that is not covered by Appendix R? If it is not safe for the operating plants, why is it not an issue to be submitted to CRGR to determine whether a generic requirement should be imposed? Since this is an issue which has been raised at several other plants, why has the generic issue not been referred to CRGR? Is the staff using plant specific backfits to circumvent CRGR? Does CRGR have appropriate authority to assure generic items are submitted for review? If so, how is it they appear to be circumvented? If not, why not? If this issue has been raised with regard to the licensing of other plants, and has been lost by the staff on appeal in other plants, why does the management permit them to continue to raise an issue which management has already decided has no merit? Why does the staff treat the Standard Review Plan as requirements contrary to Commission direction? Why does NRC management continue to permit this to happen?

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[6] On February 28, 1985, the staff held a formal appeal meeting with Duquesne on fire protection with full knowledge of the existence of the blue ribbon report and omitted any reference to it.

Probable Maximum Precipitation (PMP)

Two technical definitions of PMP are (1) the rainfall depth for a particular size basin that approaches the upper limit that the present climate can produce or (2) the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a certain time of the year. If correctly defined, it would not be exceeded. It should be noted that these definitions focus on what is possible, not what is probable. The distinction is significant. PMP appears to be defined in such a manner that its occurrence is not probable. Some analysis exists which tends to confirm this observation.

According to information provided by Duquesne, the highest actual rainfall for its geographic area in one hour was 2.09 inches in 1876. Beaver Valley 2 is designed in accord with Hydro Meteorological Report (HMR) 33 to withstand 9.3 inches per hour. HMR 33 was in effect and was a part of the NRC Standard Review Plan at the time Beaver Valley was originally designed. In fact, HMR 33 is still the only HMR mentioned in the Standard Review Plan. The staff seeks now to impose HMR 52, which requires that the site design accommodate 17.6 inches per hour. HMR 52 has not been incorporated in the Standard Review Plan nor has it been reviewed by CRGR. This, then, is a case where the licensee appears to meet the SRP but the staff is insisting on a different standard and in effect is circumventing CRGR.

Although there is no intent to pass on the merits of the case at this time, it seems appropriate to consider the risk associated with having a rainfall of that magnitude, particularly in light of the fact that HMR 52 is approximately 800% greater than any rainfall on record. Along these lines, it is interesting to note an article by Donald W. Newton in the ASCE Journal of Hydraulic Engineering 109 (6), pages 905-918, entitled, "Realistic Assessment of Maximum Flood Potentials." That article points out that PMP is developed for the purpose of flood control and evaluation of the relative risks and consequences of dam failure. The article also seems to indicate that the size of the near PMP is determined by establishing probabilities of 10^{-6} to 10^{-10}, values which are generally considered to be well beyond the realm of credibility or regulatory concern. The National Academy of Sciences has also published a recent work dealing with PMP, entitled, "The Safety of Dams, Flood and Earthquake Criteria." That study tends to confirm Newton's work.

PMP has been an issue that was raised at several plants throughout the United States. In its meeting of September 26, 1984 with the NRC staff, Duquesne suggested that this item should be a generic issue, rather than a plant specific issue. Duquesene pointed out that in the circumstance, the NRC staff would be requiring Duquesne to backfit its Beaver Valley 2 plant while leaving Beaver Valley 1 untouched. The staff quickly responded by asking Duquesne whether they wished the NRC staff to include Beaver Valley 1 in the exercise and impose the requirement there as well. The statement on the part of the staff is clearly intimidating. In my experience, this type of intimidation by the NRC staff is not unusual in such circumstances. The point Duquesne was trying to make was that if this was an important safety issue for Beaver Valley 2, it should be an important safety issue for every operating plant in the United States, including Beaver Valley 1. If not that important, it should not be considered as necessary for safety. Duquesne also pointed out that the PMP had been and was being imposed on a number of other plants which suggests generic review is appropriate.

Indeed, on May 8, 1984, Victor Stello, Deputy Executive Director, Regional Operations and Generic Requirements, sent a memorandum to Harold Denton, Director of NRR, suggesting that PMP was a generic issue and should be treated as such. On June 25, 1984, Denton responded to Stello that he did not believe PMP was a generic issue. On August 8, 1984, Stello restated his concern that PMP was a generic issue and on October 10, 1984, Denton finally agreed to submit PMP to CRGR for treatment as a generic issue, even though the staff retained its view that, "PMP methodology is consistent with previously approved procedures." Nevertheless, in March 1985, ten months after the Director of CRGR suggested the issue was generic, PMP continues to be treated as a plant specific issue in the Beaver Valley 2 appeal and other cases. This suggests that the system for pinpointing generic issues may be critically defective.

This raises several interesting questions. Is this another case of circumventing CRGR by imposing a generic requirement on a plant specific basis? Why does it take so long to identify generic issues and establish the jurisdiction of CRGR to handle those cases? Why does a Deputy Executive Director for Regional Operations and Generic Requirements need the approval and voluntary submittal of generic issues when the Director of the Office of Nuclear Reactor Regulation reports to the Executive Director for Operations? If it is safe for operating reactors to continue operations without redesigning to the new PMP, why is it unsafe for near term operating licensees?

Another interesting requirement has recently been imposed in the Beaver Valley case. The staff has requested Beaver Valley to do an analysis of the effects of accumulation of water in PMP conditions on a flat roof building with a four inch parapet. The question is, what amount of stress is created by the water that accumulates above the parapet and is the roof of the building designed to withstand that additional stress? Duquesne has already documented the fact that the roof withstands 72 pounds of pressure per square foot. Ordinary knowledge of science can be used to determine that such a roof could withstand a column of water approximately 15 to 16 inches high. Because of gravity and the inclination of liquids to achieve their lowest level under gravity conditions, it would appear highly unlikely that a column of water would accumulate 11 or 12 inches above the edge of the parapet on the roof. Nevertheless, it appears that Duquesene is being requested to make an analysis of the kind of stress that would be added above the edge of the parapet under PMP conditions.

PMP has also been applied in an extraordinary manner at River Bend. There, the licensee abandoned construction of Unit 2 while continuing to build Unit 1. Unit 2 left a large hole in the ground which the licensee intends to fill during the first cycle of Unit 1 operation. Postulating a 72 hour PMP followed by a 72 hour break followed by a .5 PMP, the staff required the licensee to propose a method of withstanding this PMP scenario. Although the licensee disagreed with the PMP scenario, at the suggestion of the staff and in order to resolve this issue, the licensee agreed to construct a berm around the hole. The estimated cost of the berm is one million dollars. The combination PMP and 15-50 percent PMP within a three day period is given the probability of 6×10^{-13} by Newton and 10^{-10} or 10^{-11} by the National Academy of Sciences. In order to give these figures perspective, note that the McGraw Hill Encyclopedia of Science and Technology assigns the probability of an Ice Age at $.25 \times 10^{-9}$.

General Observations on Licensing

Perhaps the most perplexing and difficult problem to deal with is the emergence of a regulatory culture which appears to have grown up around the general NRC licensing practices. There appears to be a deep seated set of values among the staff and staff management of the NRC which perceives there is nothing wrong in failing to follow the statute, their own rules or Commission direction with respect to imposition of requirements on licensees. In addition, that culture appears to believe that it is appropriate to impose leverage on licensees as a method of getting licensees to meet requirements for which there might not be a legal or technical basis.

The legal basis for imposing requirements is found in the enabling statute of the NRC and the rules, regulations and orders promulgated by the Commission pursuant to that statutory authority. Quite apart from rules, regulations and orders, the Commission has developed various methods for providing guidance to licensees on how to proceed with applications. Such guidance is generally stated in Standard Review Plans (SRP), Regulatory Guides, and Branch Technical Positions. Notwithstanding the fact that the Commission has specifically stated that SRPs, Regulatory Guides, and Branch Technical Positions are not requirements, the staff considers them so and uses them as if they were legal requirements. This problem is further exacerbated by the staff when it imposes requirements through an SRP which has not been updated or where no SRP exists or by individual reviewers' interpretations of SRPs, Regulatory Guides, or Branch Technical Positions. Such interpretations may be prescriptive and are not necessarily consistent among reviewers. The end result is that true requirements are difficult to identify so that both stability and fairness of the licensing process is severely impaired.

Staff action concerning SRP 3.6.2 provides an example of the staff elevating guidance to the level of a requirement. This Standard Review Plan cites a Branch Technical Position (BTP MEB 3-1) as an acceptable method for satisfying GDC 4. Although GDC 4 is a requirement, BTP MEB 3-1 is not.

Recently developed analytical methods have allowed plant designers to improve on the criteria of the BTP and reduce the number of pipe break locations which must be postulated as well as reducing the severity of the breaks. This improvement allows the designer to make plant changes which result in lower cost without adverse effects on safety and with significant reductions in personnel exposure. It will also reduce operational complexity and enhance ease of inspection and maintenance.

The staff has taken the position that this new methodology is technically acceptable and beneficial, but an exemption to GDC 4 is necessary to deviate from the BTP and, in fact a rule change to GDC 4 is now being considered. GDC 4 reads as follows:

> Criterion 4 - Environmental and missile design bases. Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit.

This criterion does not appear specific enough to warrant a rule change and the new methodology appears to clearly conform to the present GDC 4. Allowance of the new methodology would also appear to be consistent with other staff interpretations of GDC 4.

Clearly, the staff action has the affect of elevating the "guidance" of the Branch Technical Position to the level of "requirement." By its position, the NRC management and staff so integrates the BTP with GDC 4 that the two are fused into a Commission rule. The consequences of such a view give special insight to the NRC's regulatory culture. It is one thing to make guidance a requirement. It is quite another to regard it as having so amended the rule that new information cannot be taken into account without (a) applying for an exemption to the "rule" or (b) changing the "rule" through the Commission's rulemaking process. In fact, no new rule was created by the staff action and, therefore, there is nothing from which to request an exemption or which requires a rule change.

Other problems exist in the imposition of requirements. For example, the staff may require re-analysis of systems components or structures simply because there is a change in state-of-the-art methodology. It has been suggested that changes in state-of-the-art alone do not provide sufficient justification for requiring re-analysis. Some have suggested that the real question should be whether the original analysis demonstrates a reasonable assurance of protection of the public health and safety and if so, no further analysis should be required. Moreover, new methodology may provide different but not necessarily better results.

There also appear to be conflicts on requirements between the licensing staff and the regional staff. For example, an NRR reviewer may insist on review of what is in fact a regional staff responsibility. The licensee is then put in the position of having to follow an NRR direction which has a potential of being at odds with the regional staff assessment of the problem.

Another general observation is that considerable evidence exists that the staff is circumventing CRGR. This is evidenced by the fact that plant specific requirements are imposed at several different plants without going through CRGR. The staff also sometimes ignores the published Standard Review Plan, following guidelines which it believes should be in the SRP. In so doing, CRGR is again circumvented because they are supposed to approve SRP changes and the staff simply uses their own version of the SRP without submitting it to CRGR for review. Moreover, delay in resolving the generic nature of a requirement, such as the PMP issue mentioned earlier in the Beaver Valley appeal, impairs the effectiveness of CRGR and suggests that the Deputy EDO for CRGR may not have a sufficient amount of authority to carry out his responsibilities.

The question and answer exchange between the staff and licensee also presents problems. The staff regularly submits lines of questions to licensees to obtain more complete information upon which the staff might make a decision. The question and answer concept is valid and useful. However, some problems appear to exist with respect to some associated staff practices. For example, in a total of 295 questions asked recently of three different licensees, 91% of the questions were absolutely identical. There is nothing particularly wrong with pro forma questions. However, for three different plants to receive a large number of identical questions suggests that the staff should revise its Regulatory Guides to solicit such information early in the review. It may also be noted that these questions were asked late in the process. The reason for doing so is not clear. However, it would not appear unreasonable to suggest that the questions could have and should have been asked at an earlier date so as not to create undue pressure on the licensing process. It may also be pointed out that the fact that answers to staff questions are frequently found in the FSAR suggests the staff may not always have read what they are supposed to review.

There is also some evidence that there are poor communications between staff reviewers and NRC management and between NRC and the applicant. The latter may be due in part to an adversarial relationship which has developed between the NRC and the licensees and both parties may be at fault to some extent. However, it may be observed that there have been many reported instances where major managers of the NRC do not return phone calls of licensees. There are also complaints that the agency does not keep the licensee well informed of progress in its licensing. In addition, some in NRC licensing management and staff do not answer mail promptly and in many cases, not at all. On one recent occasion, an NRC manager even suggested that it was their policy not to answer an applicant's mail.

Problems also exist with project management in that there appears to be a lack of continuity, lack of experience and general inability to identify and resolve issues promptly. In addition, it appears that some reviewers are not supervised and may even intimidate their own managers by threatening to file Differing Professional Opinions (DPO) if their views are challenged. There is some evidence that upper management is perceived as regarding the issuance of a DPO as a reflection of bad management by middle managers. Consequently, middle managers are squeezed by upper managers on one side and their subordinates on the other. The squeeze puts middle managers in a defensive rather than assertive mode and the reviewer is left to his own devices.

Finally, there is a problem of regulatory intimidation of licensees. This problem is pervasive with the licensing management and staff. Sometimes intimidation is in the nature of direct threats that unless the licensee complies with desires of the staff relative to certain items, the applicant's SER, license or restart will be held up. Sometimes it is only subtle innuendo. This has gone on for years, is firmly ingrained in the regulatory culture and no one appears to be giving any direction that this is wrongful conduct.

The long term effects of intimidation have been destructive of the process. It has instilled in the institutional psyche of the industry that "the NRC will get its way in the end, so go ahead and do what they say." This further leads the industry to not insist upon its rights under the backfit rule. The staff then, has taken the position that since no one has complained, there are no backfits. That is wrong. Even though no complaint is lodged, the change is still made to systems, structures or components after a construction permit is issued. More importantly, it is made without analysis, and, therefore, without a full understanding of the consequences.

It is interesting to note that when major managers of the NRC were asked by the Commission why they had not followed the existing backfit rule, 10 CFR §50.109, they responded that licensees had not complained but simply complied with the staff's requests. Had the industry complained, these managers said, the staff would have used the rule.

A number of things are wrong with this position. First, it means that there is no guarantee that backfits will be analyzed unless an applicant or licensee complains, leaving the door open to backfits which may be unsafe or economically unjustifiable. Second, the stated management position avoids the NRC responsibility to follow acceptable scientific and technological methodology in order to protect public health and safety. Third, where the intimidation factor comes into play and licensees are discouraged from and do not take action, it may give the mistaken impression that backfitting does not exist or is a very small problem. Fourth, if one accepts that staff analysis should be a condition precedent to the imposition of a new requirement, that analysis should be automatic. No one should have to complain to trigger the staff to do the right thing. Finally, even if the foregoing points are dismissed, the fact is - the system just does not work as the key managers represented to the Commission. In the Duquesne case, for example, the company stated its concerns in a professional forthright manner. The staff did not respond initially and has taken an inordinate amount of time in resolving issues. Time creates leverage and leverage intimidates. Moreover, the staff regards Duquesne's action as adversarial and has said so. That kind of response from the NRC staff is also intimidating. But most significantly, consider the no-win situation created for an applicant or licensee. If they do not complain, the staff says there is no backfit and no problem. If they do complain, staff says the applicant is being adversarial.

Commission Actions

The Commission has taken a number of actions in its attempt to deal with backfitting and licensing problems. In 1981, it established a Committee to

Review Generic Requirements. CRGR reviews all generic requirements to assure that there is an adequate basis to impose them.

The Commission also established the Regulatory Reform Task Force in 1981. Among other things, the task force had in its charter the responsibility for looking into and improving the effectiveness and efficiency of the NRC licensing process. In so doing, backfitting was adopted as one of the primary issues of reform. Based upon task force recommendations, the Commission has proposed a rulemaking on backfitting and has directed the staff through a staff requirements memo to provide interim backfit procedures. A number of meetings have been held by the Commission over the past several years in a effort to come to grips with the backfitting and related licensing issues.

In more recent action, on December 7, 1984, Chairman Palladino sent a memorandum to William J. Dircks, Executive Director for Operations, advising that Dircks would have overall responsibility for management of backfitting. The Chairman requested information on backfits in general and Beaver Valley 2 specifically. On December 31, 1984, Dircks sent a memorandum to Chairman Palladino concerning management of backfitting. Although Dircks provided answers to the Chairman's general questions on backfitting, he did not specifically address the Beaver Valley 2 issues.

It should be pointed out that the five member Commission has not previously had the benefit of a report on backfitting and licensing practices as spelled out in this report. Moreover, they have been confronted one one hand by a licensing staff which assures the Commission that there are no problems with backfitting and licensing practices or that those problems are well under control and on the other hand, a solitary senior executive advising them that that is not the case. In the circumstance, it appears that up until the time of this report, the five members of the Commission have done about all that might be reasonably expected to solve its problems and provide solutions.

Recommendations

I. Immediate actions should be taken.

A. The Commission should direct the staff to take immediate steps to correct the problems outlined in this report and establish a feedback system to assure that Commission directions are followed. This could be done in the form of a staff requirements memo which would require, among other things, that the staff analyze a requirement as a condition precedent to its imposition. The Commission should also consider adopting the proposed backfit rule as interim guidance to the staff with instructions to immediately commence its execution.

B. Improve CRGR control over generic backfits. Under its present charter, CRGR must await action by offices subordinate to the EDO before looking into the generic nature of backfits. This unduly limits the power of the EDO to regulate backfits and to manage his organization. The charter should be revised to permit unilateral designation of generic backfits by CRGR, allowing the staff thirty days to show cause why the issue is not generic. It should also require that plant specific backfits applying to more than one plant are automatically reviewed by CRGR. The CRGR charter may also be an appropriate place to suggest that the staff shall not use unreviewed SRPs. Finally, although CRGR may not have the resources, the SRP's grandfathered by their charter should be reviewed to assure that they have an appropriate basis and are technically sound. That review should not be conducted by those applying the SRP.

C. The Commission should establish a quality assurance program for backfitting and licensing practices. That program should be headed by someone who answers only to the Commission and who is placed in a position of receiving confidential complaints from both inside and outside the agency. Annual audits should be conducted and the reports presented to the Commission for their consideration and action.

D. The Commission should establish a code of ethics for licensing practices which should provide, among other things, that the staff should avoid any appearance of intimidation in carrying out its responsibilities. Sanctions should be imposed for unethical conduct.

E. Managers all through the chain of command must be held accountable for reviewers' actions.

F. Backfits should be reviewed for commonality to determine whether there are problem branches or problem reviewers.

G. A precedent value should be established for licensing and backfitting decisions.

H. Individual interpretations of regulations should not be used for imposing requirements. A process must be established for incorporating such interpretations into the rules, regulations, or orders of the Commission so that meaningful standards exist.

I. The staff should not demand exemptions from guidance documents because they are not requirements. Existing licenses should be reviewed and exemptions from SRPs, Regulatory Guides, and Branch Technical Positions should be deleted or modified, as appropriate.

J. The question and answer program should be reviewed by the Commission. Where standard questions exist, standard answers should be acceptable and where possible, Regulatory Guides should be updated. The Commission should also take steps to assure that the FSAR is read by the reviewer before questions are asked. The numbers of questions should be reduced to the greatest extent possible. Informal inquiry may be preferable in many cases.

Questions should be asked as early as possible in the process and should not be used to create leverage. Those asked late in the process should undergo careful management scrutiny.

K. The Commission should direct that the presence or absence of Differing Professional Opinions will not affect a manager's performance evaluation.

L. The Commission should require the management and staff to answer letters and telephone calls in a timely manner. A system for tracking and management feedback should be established.

M. The headquarters and regional staff should receive extensive training in application of the backfit rule.

II. The Commission should pass the proposed backfit rule at the earliest possible date, taking the public comments into proper account.

III. A management audit should be conducted by someone independent of the NRC. The Commission should select such an auditor very carefully to assure that it has no previous ties and no bias. It should only have the objective of reviewing the present management to determine what, if any, improvements might be made. The audit should be both micro and macro. It should review management operations at all levels, staff qualifications and training vis-a-vis their responsibilities, staff practices, as well as organizational strategies and structures. Fundamental questions must be asked and answered, such as: Does the system work? If not, why not? Is fundamental policy clear? Is fundamental policy properly communicated to people required to implement it? Is there management follow-through to assure that policies work?

It may be beneficial to review and reassess regionalization in light of management findings. It is almost axiomatic that a program of decentralization requires very strong central management. If a management audit should indicate that strong central management is lacking, adjustments would apparently be necessary in either central management or regionalization.

IV. Steps should be taken to avoid inbred, stagnant management. This suggestion is directly related to both the regulatory culture problem and management effectiveness. Several things could be done. A diversified career management program could be developed to assure that no manager stays in one position for an extended period of time. It may also be advisable to occasionally fill major positions from outside the agency with people having demonstrated management skills and experience in the private sector.

V. The Commission should expend some of its resources to develop a new strategy for licensing with a view toward reorganizing to meet that strategy. In this regard, it may be beneficial to think of dividing the organization along functional lines. For example, several advantages could be gained if the Commission had three major divisions: (1) Technical; (2) Legal; and (3) Inspection and Enforcement. A few special offices for administrative services to the Commission could round out the organization.

Improving the System

The Commission has set the stage for improving backfitting and licensing practices. Appointment of the Task Force, for example, has made it possible to document problems such as those outlined in this report. Issuing a proposed rulemaking to address the backfit problem is another important step taken by the Commission.

But if real progress is to be made, three things must happen. First, the backfit rule must be adopted by the Commission consistent with the recommendations made in this report. That must be done at the earliest date possible.

Second, the Commission must closely supervise the management of the rule and related licensing practices. Commissioners must give this close personal attention, at least until they can be certain that the regulatory culture has been changed.

Third, the industry must insist upon the rights which have been created under the rule. Although intimidation has been a factor in not insisting upon the rule's enforcement in the past, there have been many instances where the choice not to invoke the rule has been made freely. Economic forces will probably change that situation for both the industry and the NRC.

The pressures on CEOs to find money and maintain cash flow has taken on new proportions in recent years. Because money is an important concern of every utility CEO in the United States, because CEOs collectively direct the course of utility policy, and because backfitting and licensing practices can have serious financial consequences, CEOs are likely to establish mechanisms within their organizations to assure that the NRC follows its own rules and does not cause the imposition of unnecessary or unjustifiable costs.

Another driving force will be state public utility commissions. Their prudence investigations have become more intense in recent years. It is not unreasonable to expect that such an audit would request a utility to provide justification for permitting a cost which might have been avoided by insisting upon imposition of a backfit rule. When a utility is caught between the NRC requiring an expenditure for an unjustifiable backfit and the public utility commission disallowing that expenditure in the rate base because the utility did not use the rule, the course of action will become clear. Utilities will be required to insist upon their rights under the rule.

In the final analysis, any rule is only as good as its implementation and enforcement. Responsibilities must be met and rights must be insisted upon.

Author's Note:

Because of the subject matter discussed and the interests involved, this report may become the subject of considerable critical analysis and comment. Differences are likely to develop over the way facts are perceived, conclusions are formed, and recommendations are made. Although the report is stated somewhat conservatively, it is candid and further investigation will reveal that it is reasonably accurate. Independent investigations such as those being currently conducted by the General Accounting Office and the Surveys and Investigations Staff of the House Appropriations Committee, should provide verification. A general survey of the industry, if made, would provide further corrobation. Moreover, many of the views expressed in this report are shared by several of my colleagues in the NRC management and staff.

Although the term, "NRC management and staff" is used throughout the report, that term should usually be read in the context in which it is made. It refers generally to the staff and management from the Executive Director for Operations down. In some cases, it may not be that broad. Many of the problems may be created by a few branches or a few reviewers. On the other hand, if one subscribes to the view that a manager is responsible for everything his employees do or fail to do, key managers in the chain of command are nearly always involved. I should also like to make it clear that I believe that those who work at the NRC are capable, dedicated public servants who want to do the right thing. Many of those directly involved in the events and issues described in this report probably think they have done and are doing the right thing. But in my view, the right thing is too often unattainable because the staff and management are engulfed in and overwhelmed by a regulatory culture which is seriously flawed. That culture can and must be changed.

I am keenly aware of the fact that issuance of this report can have far reaching effects on me personally. Even those who agree with the thrust of the report may pause to consider the wisdom of a senior executive in government who is so critical of his own agency. My explanation may not be acceptable to all, but it is straightforward. First, members of Congress asked for my personal views on licensing and backfitting, not those of the agency. In the circumstance, I believe that the Congressmen are entitled to an honest response and I am willing to live with the consequences of telling the truth. Second, I offer for consideration, the first principle in the Code of Ethics for Government Service, which states,

> "Any person in government service should put loyalty to the highest moral principles, and to country, above loyalty to persons, party or government department."

In my view, the subject of this report can figure significantly in a very important national interest, that of assuring that this nation has a well balanced energy program. When it gets down to a choice between my personal interests and the national interests, there really is no choice.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

March 14, 1985

MEMORANDUM FOR: Chairman Palladino

FROM: William J. Dircks
Executive Director for Operations

SUBJECT: BACKFITTING REPORT BY TOURTELLOTTE

This memorandum is to acknowledge the recent report by Jim Tourtellotte on backfitting and licensing practices, and to provide some preliminary comment to contribute to your perspective and understanding of the fundamental aspects of backfitting and licensing practice. There are basically two elements of the backfitting problem. Generic backfits are established for all plants of a defined type, and plant-specific backfits are unique changes applicable to only one plant.

Backfitting is indeed a basic element of the regulatory practice. It is important to understand two points with respect to this issue. First, backfitting is and has been necessary to establish and maintain adequate protection of public health and safety. The second point is that neither the backfitting regulation (10 CFR 50.109) nor the staff practices relating to backfitting are adequate and this represents a problem that needs corrective action.

Through the mid-1970s, a large number of plants were started by the industry. During that time, these plants rapidly increased in size from around 100 megawatts electric to over 1000 megawatts electric. Almost every plant is of a unique design. In addition, there are about 50 different utilities involved in the construction and operation of these plants. This rapid evolution in plant design and the large numbers of proposed plants strained both the technical and managerial capability of the industry and the regulatory capacity of the then-AEC.

As you know, plants already operating often reveal deficiencies in design or operation that warrant backfitting requirements for some or all plants operating or under construction. These include, for example, safety improvements resulting from identified deficiencies in seismic design margins, design for fire protection, equipment qualification, steam generator tube performance, pipe cracking in boiling water reactors, human factors design criteria, and others, many of which were approved by the Commission. The TMI-2 accident alone resulted in a large number of issues which were pursued by staff and industry, culminating in significant changes in nuclear plant design and operation during the last 5 years. The point is that backfitting is necessary. But we all recognize that backfitting must be pursued in a well managed and disciplined way in order to responsibly focus resource expenditures on issues that yield meaningful risk reductions and substantial additional protection. That is a responsibility which the Commission has been aware of and has pursued vigorously during the last several years.

Following the TMI accident, a large number of costly and resource-intensive requirements were imposed by the NRC. An NRC survey of licensees in 1981 (NUREG-0839) caused us to realize the problem that these backfits were creating and resulted in a recommendation that the NRC should take action to bring the issuance of requirements under better control. We recognized that improvements were necessary to systematically evaluate needed requirements to assure that the safety benefit was significant and commensurate with the cost to implement and maintain the requirement. Obviously, management of the generic backfits received first priority because of its wide impact throughout the industry. Consequently, in October 1981, the Commission established the Committee to Review Generic Requirements (CRGR) and the position of Deputy Executive Director for Regional Operations and Generic Requirements. All proposed new generic requirements are to be reviewed by the CRGR. This ongoing effort is successful. During 1982, a Commission-appointed Regulatory Reform Task Force (RRTF), headed by Jim Tourtellotte, proposed several licensing process reforms. Among these was a proposed revision to the existing backfit regulation, 10 CFR 50.109. In 1983, the Commission considered staff and industry proposals, and held several discussions from which emerged a better understanding at all staff levels of what backfitting is and what direction and form should be taken in any new Commission action.

It was recognized that establishing the CRGR did not manage plant-specific backfitting on individual plants. At Commission direction, the staff in late 1983 developed procedures to aid in managing plant-specific backfitting. The Commission also issued a Policy Statement and Advance Notice of Proposed Rulemaking in September 1983, providing an interim policy pending the outcome of the formal proceeding to amend 10 CFR 50.109. The policy endorsed both the CRGR and the interim measures directed to manage plant-specific backfitting.

In February 1984, the Commission approved the staff's procedures for managing plant-specific backfitting for operating reactors. These procedures were adopted by NRC for operating reactors and were also used as interim guidance for OLs. These procedures were made immediately effective by a generic letter from NRR. The NRC Office of Inspector and Auditor was directed at that time to prepare a report, after 1-year's use of the procedures, on the staff utilization of these procedures. That report is now being written. In addition, the General Accounting Office is also working on a Survey of Backfitting to be completed in the near future. In the meantime, the staff has been applying the procedures issued in April 1984. In retrospect, the procedures and management controls for plant-specific backfitting were not sufficient to effectively manage the process. Recognizing that even more improvements in the plant-specific backfit area were feasible, an effort was initiated in January 1985 to revise and improve our procedures. Based on experience with the procedures and on public comments received, we are effecting more centralized control, requiring cost-benefit analysis prior to requirement imposition and improving the capability to identify and process backfits. We are also explaining the backfit policy and procedures to our working level staff at seminars in all regions and offices this spring to assure a thorough understanding of the principles and practices of managing backfitting.

Therefore, our efforts are continuing at the vigorous pace that has been established over the last several years. Problems are to be expected in modifying a regulatory practice rooted in more than 20 years of history. We have vigorously identified, defined and challenged the matter of improved backfit management, and are continuing to improve in this difficult management area. Actions for many of the immediate action recommendations in the Tourtellotte report were initiated prior to issuance of that report. We do not intend to relent in our efforts to solve the backfit issue.

I believe the issues raised regarding the backfit issues on the Beaver Valley facility and the recommendations identified in the report require further comment. I will forward these comments to the Commission in the near future.

William J. Dircks
Executive Director for Operations

cc: Commissioner Roberts
Commissioner Asselstine
Commissioner Bernthal
Commissioner Zech
OGC
OPE
SECY ✓
JTourtelotte

REPORT
OF THE
EDISON ELECTRIC INSTITUTE
ON NUCLEAR POWER

Prepared by the EEI Task Force on Nuclear Power

February 1985

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The Task Force on Nuclear Power wishes to acknowledge the contribution of Mr. Everard Munsey, Executive Director-Public Policy, Virginia Electric and Power Company, in preparing this report.

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EXECUTIVE SUMMARY

American electric utilities have virtually ceased ordering new electric generating capacity of any kind. They are completing existing construction programs as rapidly as possible and are moving into a period in which little new capacity will be under development.

This impending absence of construction reflects two facts:

* **Generating capacity that was ordered in an environment far different from that in which the utilities operate today will be sufficient to meet the electricity demands for a number of years.**

* **Electric utilities now face strong economic and financial disincentives to undertake new construction.** Recent improvements in the industry's financial health are closely linked to the completion or winding down of current construction programs. On the other hand, both the utilities and the investment community recognize that major new construction is likely to cause severe deterioration in a utility's financial condition.

But demand for electricity continues to grow. In the years after the Arab Oil Embargo of 1973, total demand for energy in the United States declined. But demand for electricity grew at the same pace as the economy. While the exact rate of growth is uncertain, electricity use will keep on increasing throughout the 80s and 90s.

With a growth rate that is modest by historical standards, additional generating capacity will be needed by the mid 90s. By the year 2000, America is likely to need at least 100 to 200 million kilowatts of generating capacity in addition to the power plants now in place and under construction. If the capacity needs of the mid 90s are to be met with conventional generating units that take 6 to 8 years to build, many utilities will need to resume construction during this decade.

But the dominant public view is that electricity supplies will remain ample without any substantial additions to the current stock of generating units.

In our judgment, the United States is on a course that is full of peril. Our country has drifted into a de facto electricity policy that it would not deliberately choose. But if we can soon adopt policies shaped by a long-term view of our electricity situation, it is not too late to avert serious damage to our economy.

For future electricity needs to be met, utilities must again be willing and able to build new generating units. This requires reforms in economic regulation to assure that utilities can finance the investments they are making and to provide a reasonable treatment of the risks inherent in building electric generating plants. If too little economical generating capacity is built, the lights will probably stay on but the United States will pay heavy penalties in losses of economic growth, jobs and income.

For future electricity needs to be met at the lowest cost, utilities need to be able to choose among the best options that the state of technology will allow -- including measures to reduce demand below what it would otherwise be through conservation and by shifting use away from the times when demand is highest.

But as it is now, the principal options available to utilities are limited to demand-reducing measures and conventional coal-fired plants. Demand-reducing programs, which exist in nearly every utility system and can be expanded, can reduce or postpone, but will not eliminate, the need for new capacity.

New conventional oil and gas fired plants are ruled out by high fuel costs and uncertainties about future fuel supply, as well as by current law.

And under present regulatory and institutional arrangements, no American electric utility would consider ordering a new nuclear power plant. The cost and risks of nuclear development in the United States have become unacceptably high.

Yet, based on earlier experience in the United States, on current foreign experience and on economic analyses, nuclear power could again be an economical means of meeting future demands for electricity safely and reliably, and an option that utilities could rationally consider. The problems of the current generation of nuclear units in the United States arise not from the nature of the technology but from the way we have chosen to regulate and manage the nuclear enterprise.

Reforms that would lower the costs and risks of new nuclear units would move in the same direction and have the same purpose as the ongoing development of new non-conventional generating technologies that may have attractive costs and operating characteristics. Both will enhance the utilities' ability to serve their customers reliably at the lowest possible cost.

To address these issues, we are making recommendations in two major areas:

To consider the need for new electric generating capacity and how it can best be met, **we recommend the prompt appointment of a National Commission on Electricity.**

The Commission should consist of a small and expert group of distinguished Americans who would complete their work expeditiously and report to the President and Congress within six months. Taking into account the irreducible uncertainties, the Commission should make judgments on the future growth of electricity demand and the means by which any need can be met by both reductions in demand and increases in supply. If it finds that additional generating capacity will be needed, it should consider the circumstances under which it would again become economically rational for utilities to make major capital investments and the generating options that should be available. That would include consideration of the need for, and the nature of, actions that would again allow utilities to consider building new nuclear units.

We hope that the Commission's findings and recommendations would lead toward a national consensus on issues that have hitherto been marked by controversy and an absence of realism.

To address the problems of nuclear power, **we recommend a broad agenda of reform in the industry and in government regulation of nuclear power.**

We recommend that the industry:

* **adopt and present for licensing standard designs for new nuclear power units;**

* **maintain excellence in the operation of existing nuclear units and continue its record of safe nuclear operations;**

* **continue efforts to educate the public about nuclear power;**

* **prepare for greater use of joint ventures and separate nuclear companies** as a means of spreading risk and achieving a better match between capacity additions and load growth, and

* **develop nuclear units only through contracts providing for sharing of the risk of cost increases among the nuclear suppliers, architect-engineers and electric utilities.**

We recommend changes in Federal law and regulation so that:

* **standard nuclear plant designs are approved and units proposed to be built according to those designs are promptly licensed;**

* **nuclear plant sites are considered and approved in advance of an application to construct a plant;**

* new regulations requiring changes in design at units under construction and in operation would be adopted only if they would clearly produce substantial benefits to the public safety and health of equal or greater value than their cost;

* in place of the current two-stage licensing system, a single license would permit construction and operation once the NRC had determined that the plant as built conformed to the approved design and met quality standards;

* NRC public hearings would be more like legislative hearings and less like a trial and be limited to previously unresolved issues concerned with nuclear safety and supported by substantial facts, and

* a utility building a unit on an approved site would be able to put in place an emergency plan to protect public health and safety.

We also recommend:

* examination of the management structure of the NRC with the objective of improving the organization's effectiveness and efficiency;

* resolute action to implement the existing Federal legislation to provide for the safe, permanent disposal of highly radioactive nuclear wastes and to develop regional sites for disposal of mildly radioactive materials; and

* extension of the Price-Anderson Act with the continuation of a cap on utilities' total liability.

The crucial result of these recommendations would be to reduce sharply the time and cost required to construct a new nuclear unit and to lessen the risk of unexpected cost increases beyond the control of the utility.

Moreover these recommendations would increase the already high level of nuclear plant safety and provide for full public participation in all the major decisions concerning nuclear plant development. As the need for additional generating capacity becomes widely understood, these reforms will foster increased public support for nuclear power. Because it will take some time to restore nuclear power as an option utilities can consider, the effort should begin at once.

The electric utility industry is not attached to nuclear power for its own sake. Rather our interest and obligation is to provide reliable electricity service at the lowest cost. We advocate these reforms because we believe nuclear power, if sensibly managed and governed, can again play an important role in achieving that objective.

I. RECENT DEVELOPMENTS IN THE ELECTRIC UTILITY INDUSTRY

For more than a century, electricity has played an ever larger role in supplying the energy America needs.

The electrification of America has been especially rapid since the end of World War II. From 1945 through .1972, electricity use grew at an average annual rate of 8.1 percent. Over the same period, maximum demand for electricity, which determines the amount of electric generating capacity required, grew at an annual rate of 7.7 percent. The share of total energy supplies consumed in the form of electricity more than doubled, reaching 26 percent in 1972.

This rapid growth was the product of strong economic expansion and electricity prices that declined in inflation-adjusted terms and often in current dollars as well. Low inflation and low interest rates, moderate construction costs, technological advances and economies of scale combined to allow the utilities to bring on new generating units that could produce electricity at lower cost than their existing units. Fuel prices, measured in current dollars, changed little over the period.

Decreasing marginal costs permitted stable or declining rates for electricity users and financial health for the utilities. Increasing use of electricity contributed to increased productivity in the American economy.

With growth at a pace that doubled demand every 9 years, electric utilities were first and foremost construction companies. The need for new capacity seemed to be clear and consistent. With adequate earnings and favorable stock prices, utilities were able and willing to build. The electric utilities increased their total generating capacity from 50 million kilowatts in 1945 to

399 million kilowatts in 1972. Many regulators were urging the companies to step up their building programs.

Slowing Demand Growth

In the late 60s the picture began to change. Inflation and interest rates began to move up and increasingly stringent and costly requirements to protect the environment eroded the cost advantages of larger generating units. The forces pushing up utility costs and rates intensified dramatically after the Arab Oil Embargo of 1973. The rapid increase in fuel prices, combined with high inflation and unprecedented interest costs, required rate increases. The second energy price shock that followed the Iranian Revolution of 1978 added to the already severe cost pressures. Formerly placid regulatory proceedings became battlegrounds. Between 1973 and 1981 electric rates went up by 179 percent in current dollars and 37 percent after adjustment for inflation, but even so, utility revenues did not keep pace with soaring costs. The result was a sharp deterioration in utilities' financial condition. This was evidenced by widespread downratings of utility bonds and by utility stocks priced by the market well below their book values.

In sharp contrast to the recent past, construction costs soared to the point where the addition of new capacity of any kind would raise rather than lower electric rates unless it was displacing expensive electricity generated with oil or gas.

Rising energy prices prompted strong efforts to conserve both electrical and non-electrical energy. But while the total amount of energy used in the United States dropped between 1973 and 1983, the demand for electricity continued to grow, although at a reduced rate. Total energy use in the United States declined from 74.2 quadrillion BTUs in 1973 to 70.6 quadrillion BTUs in 1983, a compound annual decline of .5 percent. In the same period, electricity sales grew from 1.7 trillion kilowatt-hours to 2.2 trillion kilowatt-hours, representing compound annual growth of 2.6 percent. Peak demand increased from 344 to 448 million kilowatts, a compound annual growth rate of 2.7 percent. In the period since the Arab Embargo, the growth of electricity demand has closely matched the growth in the gross national product. The share of total energy supplies consumed as electricity continued to rise, reaching 35.4 percent in 1983. One of the important reasons that electricity use continued to grow while demand for other forms of energy dropped was that electricity prices rose much less than other energy prices.

The slowing of demand growth posed difficult problems for the utilities. The large generating units that provided the cheapest source of electricity require a huge capital investment. The process of planning such units, obtaining the necessary approvals and carrying out their construction extends over many years even if there are no extraordinary or unexpected delays. The generating units that were on order and under construction in the post-Embargo period had been planned when growth was rapid or before the impact of the higher prices on demand became clear. As utilities progressively reduced their forecasts of future demand, it became apparent that some of the capacity on order would not be needed for many years.

Utilities had two unattractive options. They could complete new units that would result in higher capacity reserves than they would normally maintain to assure reliable electric service. Or they could cancel the units and, in some cases, abandon substantial investments. In fact, since 1974, 220 million kilowatts of new generating capacity have been completed and brought into service. But in the same period, 148 million kilowatts of capacity on order have been cancelled. Since 1979, the pace of cancellations has accelerated and the amount of new capacity under development has been reduced by 72 million kilowatts.

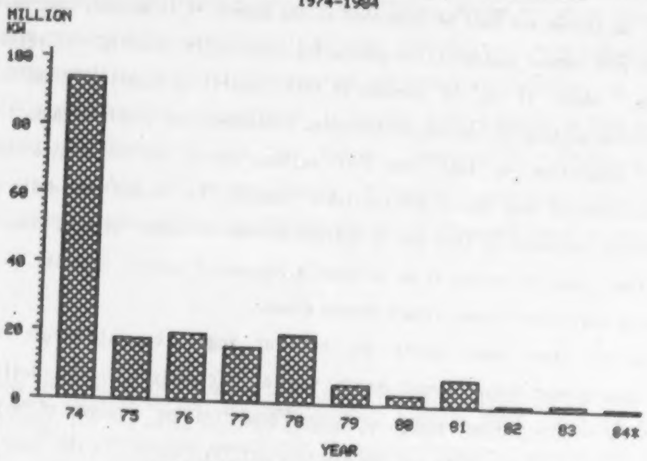
Nuclear units, as the largest units with the highest capital cost per kilowatt, were the first to be eliminated. Since 1973, 109 nuclear units with a total generating capacity of 119 million kilowatts have been cancelled. But cancellations have not been confined to nuclear units. In 1982 and 1983, nearly 19 million kilowatts of coal-fired capacity were struck from the order books compared to about 14 million kilowatts of nuclear capacity.

While units on order were being cancelled, new orders of course declined precipitiously. New orders dropped from 94 million kilowatts of capacity in 1974 to a range of 16 to 20 million from 1975 to 1978 and fell further to between 3 and 8 million kilowatts for 1979 to 1981. In 1982 through 1984, new orders have practically dried up. This trend is shown in Chart 1.

CHART 1

New Generating Capacity Ordered

1974-1984



*Actual orders, first half of 1984.
Source: EEI Electric Power Survey data.

The Present Capacity Situation

As of 1984, total generating capacity in the United States amounted to 604 million kilowatts. Total peak demand in the summer of 1984 was 450.6 million kilowatts, providing a "capacity margin"[+] of 25.4 percent. Because electricity cannot be stored and must be generated at the moment it is needed, some margin between peak demand and installed generating capacity is essential for reliable service. About 17 to 18 percent of total generating capacity is typically unavailable because of routine maintenance, breakdowns and problems that limit units' generation to less than their maximum levels. Furthermore, a margin between expected peak demand and available capacity is needed to deal with unexpected increases in load due to extreme weather or other factors. Thus the utilities' capacity margin is by no means a measure of excess capacity or of capacity available to meet future demand growth.

On the other hand, while the bulk of today's capacity margin is not available to meet future demand growth, some of it clearly is. The desirable capacity margin varies among utilities depending on a number of factors. Nevertheless many utilities and the electric utility industry in the aggregate now have higher capacity margins than the utilities would chose solely to maintain reliability.

While virtually no large generating units have been ordered in recent years, approximately 90 million kilowatts of capacity remain under construction -- of which 52 million kilowatts are nuclear and 33 million are coal-fired,

---

[+] The "capacity margin" is calculated by dividing the difference between the peak load and the total generating capability by the total generating capability.

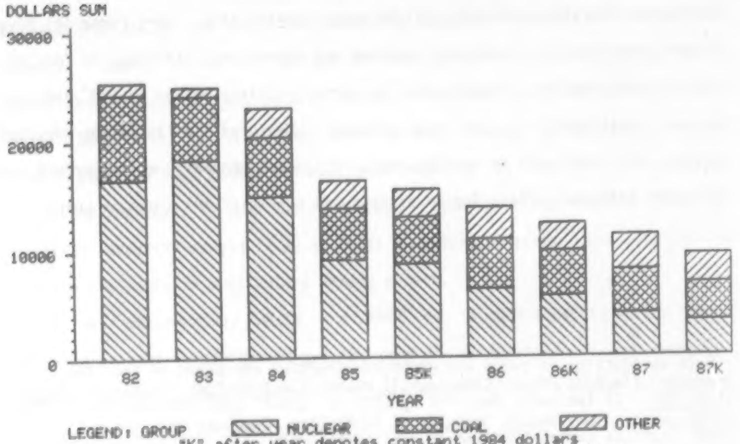
with the remainder mostly conventional and pumped storage hydroelectric.[+] Some of these units may not be completed or permitted to operate. However if demand grows at the rate forecast by the industry and most of the construction in progress is completed, the average capacity margin for the nation will rise nationwide until about 1986.

The electric utility industry is coming into a period in which relatively little new generating capacity will be under construction. Many companies have already completed their building programs and others are striving to do so. Utility construction expenditures in current dollars peaked in 1982 and will decline significantly in the near future. Measured in inflation-adjusted dollars the drop will be much sharper. Projected expenditures in current and inflation-adjusted dollars for investor-owned utilities are shown on Chart 2.

[+] Data on capacity in place and under construction are based on the 1984 North American Electric Reliability Council report Electric Power Supply and Demand, 1984-1993. Of the units reported by NERC as under construction, 11 nuclear units with a generating capacity of 12 million kilowatts received full or low power licenses during 1984 and 15 coal units with 8.5 million kilowatts of capacity were completed.

CHART 2

INVESTOR-OWNED UTILITIES
CONSTRUCTION EXPENDITURES ON ELECTRIC GENERATING PLANT
DURING 1982-1987 IN MILLIONS OF DOLLARS



"K" after year denotes constant 1984 dollars
Source: EEI 1984 Investor-owned Utility Construction Expenditure Survey.

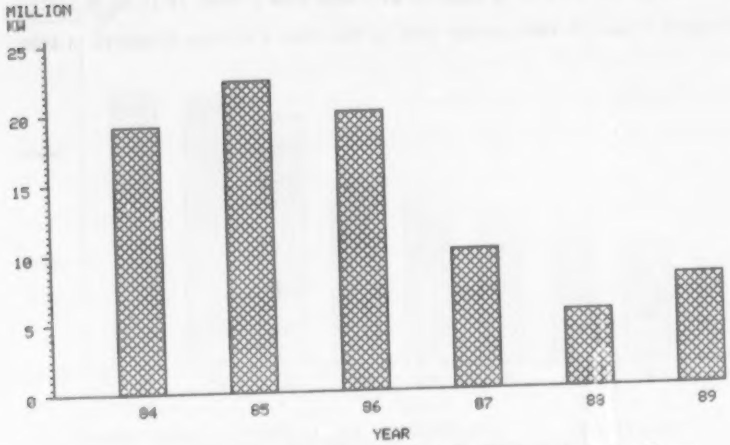
This decline in utility construction will have large effects on employment and income in the construction industry.

With the virtual absence of new orders, continuing cancellations and the completion of units under construction, the amount of generating capacity under development is declining sharply. As shown on Chart 3 following, annual additions of new generating capacity will drop from a level of 19 to 20 million kilowatts a year in 1984 through 1986 to less than 6 million kilowatts in 1988.

CHART 3

Annual Additions to Generating Capacity

1984-1989



Source: North American Electric Reliability Council, Electric Power Supply & Demand 1984-1993.

II. FUTURE DEMAND GROWTH AND HOW IT CAN BE MET

Under present circumstances electric utilities have strong economic incentives to avoid new investment.

Many companies still earn less on a new investment than the cost of the capital that is financing it. With substantial construction programs, most companies will still have to sell stock at less than book value and thereby dilute the investment of existing stockholders. Efforts to finance construction are likely to severely strain a utility's financial condition and threaten a reduction in its bond rating.

Construction, especially of larger projects with long lead times, is risky. Utilities face the possibility of penalties -- such as not being allowed to earn a return on their entire investment -- if demand growth proves to be less than they expected. And because there are psychological limits on the size of the rate increases regulators will grant, companies' earnings are likely to suffer since revenues will be inadequate to both pay for the new capacity and provide a fair return on the companies' total investment.[+]

Yet sooner or later new generating capacity will be necessary to supply the electricity that Americans need and want.

The amount and the timing of this capacity requirement will depend on a number of factors:

* the rate of growth in demand for electricity;

* the amount of existing capacity that is retired;

[+] This phenomenon was illustrated in the 70s when rapidly rising fuel costs exhausted public and regulatory tolerance for rate increases with a resulting squeeze on real returns on stockholders' investment.

* the ability of utilities to take greater advantage of existing capacity, and

* the extent of conservation and load management programs that make peak electricity demands lower than they would otherwise be.

Projecting Demand Growth

For analysis, demand growth can be most usefully viewed as the increase in electricity demand that would occur after allowing for conservation by customers in response to the prices they must pay, including any direct government subsidies for conservation. Programs by utilities that induce further conservation or shift customer demand away from peak periods are among the options available to utilities to respond to demand growth. Within limits, these demand-reducing programs are the functional equivalent of adding generating capacity.

Despite extensive and sophisticated analysis, the future growth of electricity demand remains uncertain and controversial. Analysts have projected growth of electricity demand ranging from less than one percent to about five percent annually over the next 10 to 15 years.+

The issue is usually approached through either econometric analyses or end-use analyses, and sometimes a combination of the two. Econometric analysis attempts to predict electricity demand based on its relationship to various economic factors. The most important of these factors are real (inflation-adjusted) growth in gross national product, the price of electricity and the price of competing energy sources.

+ A number of studies of electricity demand and capacity needs are briefly described in an appendix to this chapter.

The difficulties with this approach are that none of the economic variables is known with certainty and the relationships between those variables and electricity demand may be different in the future than in the past, even the recent past. Specifically, the economic growth rate over the next 10 or 15 years will depend on national policies, micro-economic developments and world events about which analysts can only make plausible assumptions. Furthermore, while changes in electricity demand and GNP have been closely correlated since the Arab Embargo, this relationship is obviously not a law of nature. The recent one-to-one relationship between electricity growth and GNP was much higher in the past and it could move up or down in the future. The relations between changes in prices and changes in demand -- the "demand elasticities" -- are also uncertain.

Different, but no less intractable, problems attend end use analyses. Such studies project electricity demand by estimating the number and character of electricity-using equipment and processes -- for example, the rate at which builders and homeowners will install electric heat pumps, the role that electric arc furnaces will play in steelmaking and the number of industrial pumps and home appliances replaced by more efficient equipment. This involves forecasting the structure of the economy, technological changes and the rate at which innovations will be adopted by businesses and households. These types of projections are problematic and become increasingly so the further ahead one tries to look.

The best analysts can do is to establish reasonable ranges for the various determinative factors and relationships. Picking a most probable value is more a matter of informed judgment than science.

Projections based on midrange values and scenarios judged to be most probable place future growth of electricity demand in a range of 2 to 3 percent annually. The industry itself, through the projections of individual companies aggregated by the North American Electric Reliability Council, is projecting growth in electricity demand of 2.5 percent annually through 1993.

Unit Retirements

The second factor affecting the time when new capacity is needed -- the amount of existing capacity that will be retired -- is substantially less uncertain. Central station generating units are normally expected to have operating lives of 30 to 40 years. By the year 2000, about 115 million kilowatts of existing generating capacity, other than hydroelectric plants, will be over 40 years old. However, under present economic circumstances a great majority of these units will remain in service. Utilities are finding it less costly and less risky to refurbish and extend the lives of aging units than to face the challenges of building new replacement capacity.

The major uncertainty related to the ability of the utilities to keep older units in service is the possibility of new environmental requirements affecting those units. If older units become subject to stringent new controls on emissions, and especially if they are required to add control equipment that is very costly or cannot be physically accommodated, the number of retirements may shoot up. Environmental controls that required general use of flue gas scrubbers+ would also increase the need for new capacity by reducing the deliverable electricity from existing units. The scrubbers would claim a significant share (in excess of five percent) of the units' output for their own operations and also reduce the units' reliability.

+ Flue gas scrubbers, which are now required on new coal units, remove sulfur dioxide from the gasses being discharged from the unit. They are bulky and very costly. In many cases, scrubbers would cost more than the original cost of existing coal units.

The need for new generating capacity may also be increased by economic developments that make use of oil and gas units even more unattractive than it is today. At present, oil and gas units, other than those designed for serving peak demand, total about 150 million kilowatts and represent about 25 percent of installed generating capacity. In some cases, given the current oil market conditions, costs to customers would be lower over the longer-term if oil units were converted to coal.

If oil and gas prices again rise in real (inflation-adjusted) terms, the penalty to customers for utility use of those fuels will increase. But one of the unfortunate results of a failure to correct the disincentives for utility investment will be to drive utilities to increased reliance on oil and gas units, possibly at the very time of a renewed surge in world oil prices.

In addition, the need for new capacity will be increased by any further cancellations of units now under construction and already included in projections of future generating capacity.

Using Existing Capacity More Efficiently

Utility efforts to take greater advantage of existing capacity will, of course, make the need for new capacity less than it would otherwise be. Increased trading in capacity can allow surpluses in one company or region to meet the needs of other areas that would otherwise need to build. The electric utility industry is now quite diverse. Growth of demand varies considerably among companies and regions, reflecting differences in underlying economic growth and the effects of varying rates of change in electricity prices. In some service areas and regions, electricity rates are rising sharply while in others they are stable or declining in inflation-adjusted terms. While capacity trading is limited by distance and the availability of transmission capacity, there will be numerous opportunities for advantageous transactions.

In some cases, investment in added transmission capability may be an economical alternative to building new capacity.

Improvements in existing units can increase their maximum output and, by increasing the units' reliability, can allow a reduction of target capacity margins. Lower target capacity margins would mean that a smaller amount of capacity would be needed for any given level of peak demand. Investments in improving existing units often provide added capacity, actually or in effect, at a lower cost and with less risk than new construction.

Demand-reducing Programs

The fourth factor affecting the need for new capacity is the reduction in demand that results from programs to promote conservation and load management. As noted above, demand as used here already includes the conservation that results primarily from electricity customers' responses to the prices they face. Price induced conservation is obviously already substantial. It is a principal reason electricity demand grew much less rapidly after the Arab Embargo than before. Even if electricity prices, on average, rise only very modestly in real terms for the remainder of the 80s, the lagged effects of past increases still provide incentives for conservation. In addition, nearly all utility companies already have more or less extensive programs to foster conservation and to reduce peak loads. These include such activities as conducting home energy audits; encouraging increased insulation; promoting energy-efficient appliances, business equipment and lighting; creating rates based on the time electricity is used; and arranging for the interruption of certain electric service during periods of peak demand.

Existing and planned programs, as well as price-induced conservation, have been considered in the utilities aggregate forecast of 2.5 percent annual demand growth. However there is sharp controversy over how much additional demand reduction can be achieved through conservation and load management programs.

Some analysts argue that conservation measures that are less costly than any means of increasing supply can eliminate most, if not all, of the need for new capacity before 2000 -- even if the underlying growth of demand is as much as three percent per year.

Such findings have two major flaws:

* They fail to distinguish the conservation that is already expected to occur and is already included in demand forecasts. They therefore end up counting some of the conservation possibilities twice.

* They fail to come to grips with the institutional problems involved in achieving energy-efficiencies that require customers to change their behavior and to make investments with long pay-back periods.

In any case, the role of conservation and load management cannot be decided in the abstract but only through conscientious efforts by utilities to assure that they respond to demand growth in the best way available -- whether that is by increasing supply or reducing demand. It is, and should be, the general philosophy of the industry that a kilowatt saved is often better than a kilowatt built.

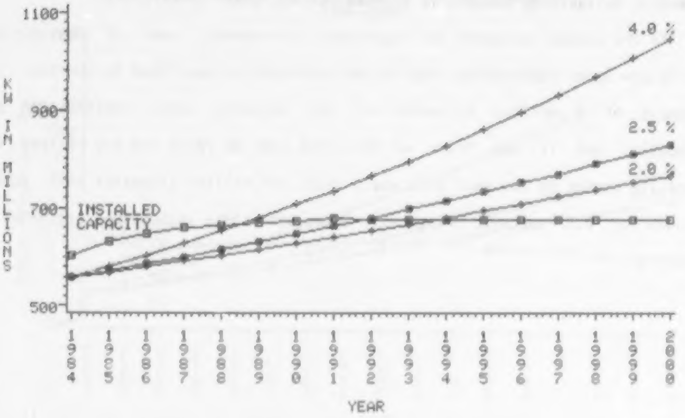
The Need for New Capacity

As might be expected, uncertainties about all of the factors affecting the need for new capacity result in a range of estimated need. It is possible that the additional generating capacity needed by the year 2000 could be as little as a few million kilowatts and as much as 500 million kilowatts -- or about three quarters of today's installed capacity.

The following chart shows the need for new generating capacity -- or additional demand-reducing measures -- with different rates of growth of peak demand and assuming the completion of all of the generating units now under construction and no capacity retirements other than about 15 million kilowatts reported to the North American Electric Reliability Council as planned through 1993.

CHART 4

U.S. ELECTRIC GENERATING CAPACITY AND PEAK DEMAND •
1984-2000



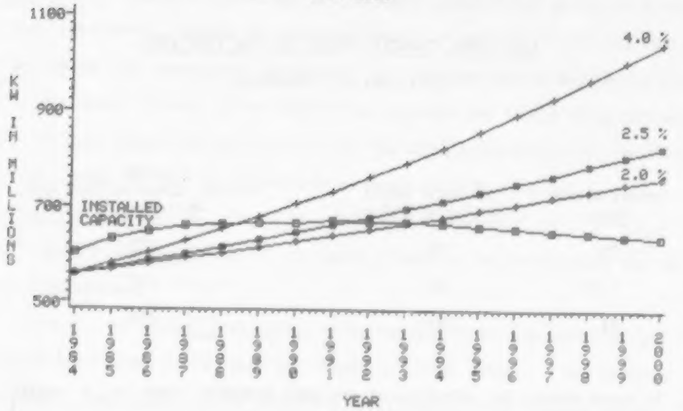
NOTE:
PEAK DEMAND AT STATED GROWTH RATES WITH 20% CAPACITY MARGIN NEEDED FOR DEPENDABLE SUPPLY. INCLUDES EXISTING CAPACITY AND CAPACITY UNDER CONSTRUCTION LESS RETIREMENTS OF 15 MILLION KILOWATTS THROUGH 1993 AS REPORTED TO NERC.

With demand growth of 2.5 percent and a capacity margin of 20 percent, additional capacity is needed by 1992 and a total of 152 million kilowatts of new capacity or demand reductions will be needed by the year 2000. Of this need, 34 million kilowatts of capacity have been reported to North American Electric Reliability Council as planned but not under construction.

In the present economic and regulatory environment, some of the nuclear units now under construction may not be completed or permitted to operate. For example, if 8 million kilowatts of the capacity under construction are cancelled and if one third of the units over 40 years old are retired, the capacity needed by the year 2000 would total 192 million kilowatts with demand growth of 2.5 percent. Capacity needs with these assumptions are shown on Chart 5.

CHART 5

U.S. ELECTRIC GENERATING CAPACITY AND PEAK DEMAND
WITH POSSIBLE CANCELLATIONS AND RETIREMENTS
1984-2000



NOTE:
PEAK DEMAND AT STATED GROWTH RATES WITH 20% CAPACITY MARGIN NEEDED FOR DEPENDABLE SUPPLY. INCLUDES EXISTING CAPACITY LESS RETIREMENTS REPORTED TO NERC AND ASSUMED RETIREMENTS AFTER 1993, AND CAPACITY UNDER CONSTRUCTION LESS ASSUMED CANCELLATIONS.

The amounts of additional generating capacity needed by the year 2000 with different assumed rates of growth in peak demand and with alternate assumptions concerning cancellations and retirements are shown in the following table.

Table 1

ADDITIONAL CAPACITY NEEDED BY THE YEAR 2000

(millions of kilowatts)

Annual Growth Rate	No Retirements or Cancellations	Limited Nuclear Cancellations and Retirements
2%	89	129
2.5%	152	192
4%	369	409

As noted above, the selection of the most probable need is a matter of educated judgment. But such judgments must be made by the electric utility industry and by public policy-makers.

With growth rates of GNP and electricity demand that are moderate by historical standards, a very modest assumption concerning cancellations and retirements, and allowing for achievable incremental reductions in demand, we judge that 100 to 200 million kilowatts of new generating capacity will be needed -- in addition to units still under construction today -- before the year 2000.

With the disincentives to building that now face the electric utility industry, that is a daunting prospect for the industry and a challenge for the nation. The danger in the present situation is that decisions not to build that are in the best interest of the individual utilities will not add up to a result consistent with the national interest in adequate generating capacity.

Several studies[+] have indicated that the economic value of electricity that is not available when needed is very high. The costs of electricity shortages show up in losses of production and foregone productivity gains and economic growth. Businesses seeking to avoid the impact of reduced reliability may also incur costs for emergency generators or for spoilage of perishable items. While the direct effects of an electricity shortage are likely to be focused on the business sector and particularly on industry, individuals will be affected through losses of jobs and income and personal inconvenience.

The Utility Options

A utility seeking to respond to demand growth at the lowest cost now has a number of options:

It can, as noted previously, carry out additional conservation and load management programs or it can buy capacity from others. In addition to purchases from other U. S. utilities, utilities in some regions can buy from Canada, with the harm to our trade balance and the transfer of jobs which that involves. In other areas there may be large opportunities for purchases from

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[+] Costs and Benefits of Over/Under Capacity in Electric Power System Planning (Electric Power Research Institute, Palo Alto, California, October 1978). Environmental and Socioeconomic Consequences of a Shortage in Installed Generating Capacity (Electric Power Research Institute, Palo Alto, California, June 1982).

cogenerators -- businesses who are generating electricity as a by-product of their basic production activities -- and from private non-utility owners of small power plants. At present there are statutory limits on the ownership, technologies and size of non-utility power production.++

Utilities have, or soon will have, a number of non-conventional options that are in varying stages of development. Two of the most promising technologies are:

* fluidized bed coal units, which have low emissions of sulfur dioxide and nitrogen oxides and

* gasification combined cycle units, which use gas produced from coal with high efficiency.

There are other attractive possibilities which are, however, unlikely to be able to provide large amounts of new capacity before the year 2000. These include:

* solar photovoltaic cells, which produce electricity directly from sunlight;

* fuel cells, in which a hydrogen-rich gas is converted chemically into electricity; and

* wind turbines that apply modern technology to an ancient source of energy.

++ There are important issues of economic efficiency and equity related to current requirements for utility purchases of power from cogenerators and private, non-utility producers. These issues should be addressed in considering how best to provide for future electricity needs.

All of these technologies are under active development with the support of the Electric Power Research Institute -- the independent research group funded by the utility industry -- and individual companies. A number of pilot plants and demonstration projects are in place. Some of these technologies may be ready for commercial application by the time many utilities must again build new capacity. However, as with any new technologies, problems and difficulties can be expected in their early commercial utilization. There will be inevitable uncertainties about their costs and performance that will limit the size of the initial commitments that utilities can prudently make.

Finally, the utilities' list of choices includes just one conventional option: coal-fired generating units.

The high cost of fuel and uncertainty about the future reliability of supplies, as well as current Federal law, rule out new conventional oil or gas-fired units for baseload generation.

Conspicuously absent from the list of available options is nuclear power. A new nuclear unit is now an option no American utility will choose -- even when demand growth clearly requires new generating capacity. And that is true despite the facts that existing U. S. nuclear units are producing some of the least costly electricity in America and that other technologically sophisticated countries continue to develop nuclear power.

The remainder of this paper explores how this came to be and what should be done about it.

APPENDIX TO CHAPTER II

A number of recent studies have attempted to forecast the future growth of electricity demand.

* The Department of Energy's Office of Policy, Planning and Analysis projected growth in the number of kilowatt hours demanded using what were considered reasonable ranges of values for four key determinants of electricity growth: real gross national product, energy prices, the long-term price elasticity of demand and elasticities related to income and technology. Using all possible combinations of high and low values for those variables, electricity demand growth ranged from .84 percent to 4.12 percent for the period 1981 through 1990. With midrange values for three of the four variables and a high or low value for the fourth, growth rates ranged from 1.56 percent to 3.29 percent in 1981 through 1990 and 1.73 percent to 2.98 percent from 1981 through 2000. The GNP growth rates assumed ranged from 2.04 percent to 3.16 percent. Using midrange values for all four variables, electricity demand was projected to increase by 2.49 percent annually from 1981 to 2000.

The study did not project growth in peak demand for electricity. However it considered the likelihood of a shift in the relation between electricity usage and peak demand and concluded that there were not persuasive reasons for expecting a decisive change. In that event, peak demand would grow at the same rate as total usage. (DOE, Office of Policy Planning and Analysis, The Future of Electric Power in America, Economic Supply for Economic Growth, Washington, D. C., June 1983, Chapter 3.)

* The U. S. Congress's Office of Technology Assessment assumed GNP growth of 2.5 percent and tested eight combinations of varying increases in electricity and gas prices and varying demand elasticities. The study projected increases in electricity demand that ranged from 1.1 percent (with

high electricity price increases, moderate gas price increases and high demand elasticities) to 4 percent (with high gas price increases, low electricity price increases and low demand elasticities).

(U.S. Congress, Office of Technology Assessment, Nuclear Power in An Age of Uncertainty, Washington, D. C , February 1984, Chapter 3.)

* The Library of Congress' Congressional Research Service made projections assuming GNP growth of 1, 3 and 4 percent. It also assumed three rates of increase in real electricity prices and a scenario for the real "composite energy price" assuming a decrease from 1983 through 1985, stability until 1990 and 2 percent escalation to the year 2000. CRS projected an increase in peak demand of 1.7 percent annually from 1982 to 2000 with low GNP growth and high electricity price increases, and an increase of 3.6 percent annually with high GNP growth and low electricity price increases. The CRS "middle case", predicated on midrange assumptions concerning GNP growth and electricity prices, projected growth of peak demand of 2.6 percent.

As in the Department of Energy study cited above, the CRS analysis indicated that GNP was the primary variable determining electricity demand.

(U. S. House of Representatives, Committee on Energy and Commerce, A Perspective on Electric Utility Capacity Planning, Washington, D. C., August, 1983, pp CRS 3-7.)

* The Department of Energy's Energy Information Administration in its Annual Energy Outlook published in 1984 projected growth of electricity usage of 3.5 percent annually from 1983 to 1990 and of 2.8 percent a year from 1990 to 1995. EIA assumed an average annual growth of real GNP of 2.9 percent between 1983 and 1995. It also assumed that real oil prices would decline until 1986 and rise thereafter to $50 (in 1983 dollars) by 1995. EIA did not specifically project growth of peak demand.

(Department of Energy, Energy Information Administration, Annual Energy Outlook, 1983, (Washington, D. C., May 1984)

* Among the major private economic forecasting organizations, Data Resources Inc., recently forecast growth in electricity sales of 3.27 percent annually from 1984 to 1994, and Wharton Econometric Forecasting Associates, Inc. forecast electricity sales growth at 2.3 percent per year from 1984 to 1994.

(Autumn 1984 DRI Energy Service Forecast; Wharton's Long-Term Forecast, September 1984.)

* Some studies have projected very low rates of growth of electricity demand. Two of these studies and the demand growth rates that they project are:

-- Committee on Nuclear and Alternative Energy Systems: in eight scenarios, generally less than 2 percent.

-- National Audubon Society: -.8 percent.

These studies generally anticipate GNP growth in the range of 2 to 2.8 percent annually. But they project low growth in electricity demand because they generally assume a small customer response to the increased price competitiveness of electricity relative to other forms of energy, or they foresee a relatively larger increase in electricity prices and/or smaller increases in other energy prices than other studies. As a result, they foresee an end to the long-term trend toward increased electrification in the American economy.

* An analysis by John R. Siegel and John O. Sillin forecasts annual growth in electricity demand of 4.5 percent a year through 1990.

This forecast is based on relatively rapid growth of GNP at 3.5 percent per year, low increases in electricity prices, and improved price competitiveness and strong movement to electricity using technologies.

Sillin is a manager specializing in public utilities with Alexander Grant & Co. and Siegel is manager of special licensing projects at the Atomic Industrial Forum.

("Rethinking Utility Strategy under Conditions of High Growth", Public Utilities Fortnightly, September 13, 1984.)

III. WHY UTILITIES WILL NOT NOW OPT FOR NUCLEAR POWER

For American utilities, the costs and risks of nuclear development have become unacceptably high.

In the early 1970s, units were completed for $150 to $300 per kilowatt of generating capacity. That means a one million kilowatt unit+ would have a total cost of as little as $150 million. By the late 70s, the capital costs of new nuclear units had risen substantially -- to about $1300 per kilowatt. At that higher cost, nuclear power in most instances still represented the lowest cost means of generating additional electricity.

For the nuclear units built and being built in the 80s, the capital cost varies greatly -- from as little as about $900 a kilowatt to more than $5,000 per kilowatt.

Since the early days of nuclear power, the cost of a nuclear unit has increased by up to 1500 percent. Only about 150 percent is attributable to general inflation and the increase in the cost of nuclear plant components. The largest part of the increase has been caused by a proliferation of regulatory requirements, construction delays and increased financing costs. In some cases, cost increases occurred because the utilities were unequipped to cope with the growing complexity of nuclear projects and the pace of change.

+ In fact, the early units were somewhat smaller in size -- about 700,000 to 800,000 kilowatts.

Open-end Nuclear Construction Costs

While there are important steps that the utilities themselves can take to keep costs down, no utility can now be sure that it will not be affected by developments beyond its control that will drive up the cost of the unit it is building and plunge it into economic and financial disaster.

Regulatory requirements applicable to nuclear units began to increase significantly in the early 70s. Following the accident at Three Mile Island in 1979, the flow of new requirements became a flood. By the early 80s, the Nuclear Regulatory Commission had issued nearly 2,000 regulatory guides, letters, bulletins, orders, notices and standards governing the U. S. nuclear industry. Many of the new requirements were necessary and appropriate, but many others made no significant contribution to safety or failed to provide benefits commensurate with their cost.

The problems arising from new regulations have been compounded by ambiguities concerning their requirements, inconsistent interpretations by NRC officials and difficulties in obtaining timely decisions on utilities' compliance plans and actions.

In any event, the new regulations had large impacts on cost, especially when they required the removal and replacement of existing construction and the addition of structures and equipment to areas not designed to accommodate them. The new regulations were mainly reponsible for large increases in the quantity of materials and manpower required for nuclear units. For example, the amount of electric cable used in nuclear units increased from about 2 feet per kilowatt in the early 70s to as much as 7.3 feet per kilowatt about a decade later. Concrete use jumped from about 90 cubic feet per 1000 kilowatts to as much as 290 cubic feet per 1000 kilowatts. Craft labor requirements soared from 3.5 workhours per kilowatt in the early plants to more than 21 workhours per kilowatt for units under construction in the early 80s. The costs of materials used in nuclear construction also increased as a result of regulatory requirements. For example, structural steel supports used in nuclear power projects now cost up to three times as much as the same quality supports used in general construction.[+] As suggested above, some of the increases in materials and manpower were appropriate but a considerable number were not justified by any resulting improvement in safety.

The increased cost of the units being completed in the mid-1980s means that most of them will not generate electricity as cheaply as most new coal units equipped with flue gas scrubbers. And the total cost per kilowatt-hour of the more expensive of the new units will be less than that of oil units only if and when oil prices again rise in real (inflation-adjusted) terms.

However, increases in costs to the point where coal units would have been cheaper does not mean the nuclear units under construction should be cancelled. On the contrary, most of those units should be completed. Most of their cost has already been invested. The relevant economic comparison is between the total cost of the coal plant or other alternative (plus the cancellation costs of the nuclear unit) and the additional or incremental cost of completing the nuclear unit. Even when the nuclear unit is not needed immediately and the more distant costs of completing an alternative generating unit are discounted to allow for the time-value of money, the cost of the alternatives will usually be greater than the incremental cost of finishing a substantially completed nuclear unit.

[+] U.S. Congress, Office of Technology Assessment, Nuclear Power in an Age of Uncertainty (Washington, D.C. 1984).

If public policy -- including regulation by the NRC and state utility commissions -- is such that nuclear units now under construction cannot be completed in cases where completion would be economically sensible, the resulting psychological and financial impacts on the electric utility industry will make it all the more difficult for utilities to ever again order nuclear units.

The problem with nuclear costs is not only that they now can be expected to be high, but also that they can increase unpredictably. Under present circumstances, a utility cannot determine the cost of building a unit that complies with all requirements existing at the time and then expect to build that unit. Unknown changes in regulatory requirements can and will be made while the unit is under construction. A utility can have little idea what impact such changes will have on its costs.

The Danger of Delays

Costs will also be increased by delays in the construction schedule. Given the huge amount of capital involved, delays can push up costs dramatically as the interest and other carrying costs on the capital mount and as the effects of general inflation multiply.

Some of the delays that are affecting the units now under construction were initiated by the utilities themselves. When demand growth slowed sharply, some construction was suspended while the companies decided whether to complete the units.

But most delays result from factors largely or wholly beyond the control of utilities: regulatory actions both by the NRC and by state authorities, intervention by opponents of nuclear power and financing difficulties.

Present regulatory procedures afford numerous opportunities for anti-nuclear activists to raise issues that delay the completion and operation of nuclear units. Nuclear opponents are well aware of the potent effect of delay on the cost of the nuclear plants. They have become adept in using their procedural rights in ways that raise nuclear costs. For example, allegations of deficiencies in the quality of construction completed months or even years earlier have been made without substantial factual evidence. Even when those claims are later dismissed by the NRC as unfounded, they have delayed the issuance of operating licenses for months while, in some cases, interest costs increased by hundreds of thousands of dollars per day.

Delays have also resulted from financing difficulties as rising costs have overwhelmed the owners' ability to raise capital, and as expected cash flow was reduced by slower than anticipated growth of demand and revenues. In a number of well known cases, the effects on the utility's financial condition of building a nuclear unit have become so severe that the company has been closed out of the capital markets. Even when access to capital can be re-established, the delay while the cure is effected adds further to cost. With a 13-year lead time for construction, the carrying costs on the necessary capital can constitute 60 percent of the cost of a nuclear plant. By comparison, with a construction time of 5 years and no change in other basic assumptions, the carrying costs on the capital would represent only about 30 percent of the plant cost.

The slower growth of electricity demand has undoubtedly fostered delays. In some cases, the lack of immediate need for capacity has reduced the pressure on regulators for actions that would allow prompt completion of the units.

Regulatory Risks

In contrast to coal plants and some of the non-conventional generating options, nuclear units have relatively high capital costs and low fuel costs. This is advantageous in reducing the risk of higher electricity costs due to fuel price increases over the life of the unit. But under traditional utility accounting, capital-intensive projects have a disproportionate effect on rates in the units' early years. The initial revenue requirements for nuclear units can result in large rate increases even when the total cost of electricity generated by the unit over its life will be less than other options. Nuclear units present a particularly aggravated instance of the problem that all new units are more costly than those on which current rates are based and therefore tend to raise rates.

Some regulators have required -- and some utilities, seeing no better option, have proposed -- that the rate increases to pay for a new nuclear unit take effect in stages over a number of years. This of course tends to perpetuate the financial weakness caused by the construction efforts. The prospect of protracted financial difficulty during a period in which higher rates are phased-in constitutes another deterrent to nuclear construction.

Nuclear power also appears increasingly subject to a non-symmetrical treatment of utilities' construction performance. When unit costs turn out to be higher than anticipated, utilities are subject to penalties. On the other hand when units are built at low cost -- and there still are relatively low cost units among those being completed in the 1980s -- the benefits are passed through fully to the company's customers. This lack of balance between risks and rewards in nuclear investment has been characterized as "Heads you win, tails I lose." Another regulatory risk is the growing tendency of regulatory commissions to conduct after the fact reviews of the "prudence" of investments in units already in operation.

Lengthening Construction Periods

Since the early 70s, the period required for construction of a nuclear plant has increased from an average of 70 months to an average of 120 months, with some under construction for as long as 160 months.+ This extended construction time increases the total cost of the unit as noted previously. Moreover, it has required utilities to forecast further into the future and increases the period in which they are exposed to possible declines in anticipated growth. For reasons already discussed, demand forecasts are inevitably uncertain. Nuclear units with their large generating capacity and extended construction periods are particularly exposed to the risks that result from that uncertainty. If growth turns out to be less than expected when the unit was begun years earlier, the result could be cancellation of the unit or its completion with the creation of reserves above desired levels. In either case, there is a high risk of penalties as stockholders bear some or all of the costs of cancellation or as regulators deny earnings on the investment in "excess" capacity.

Nuclear construction also runs the risk that a plant will be completed but never be allowed to operate. As it is now, nuclear construction proceeds under a Construction Permit. After the plant is complete it is subject to a new and separate procedure for an Operating License. While the theoretical possibility

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+ This increase in construction periods can be reversed by the implementation of recommendations presented in this report.

that an operating license could be denied to a completed plant has never finally materialized, the risk cannot be ignored. Recent initial action by an Atomic Safety and Licensing Board to reject an Operating License has made clear that the risk is real.[+]

Even if Federal authorities are prepared to permit a nuclear unit to operate, local governments near the plant may be able to block its operation by refusing to participate in the required emergency plan if they are backed, or at least not overruled, by the state government. Given the possibility for changes in government personnel and policies over the construction period of a nuclear unit, no company can be sure of avoiding this hazard.

Finally, a fundamental factor affecting utility willingness to develop new nuclear units is the attitude of the public. In recent years public attitudes toward nuclear power have become more negative and this shift has, and will have, pervasive effects on the legal and regulatory climate. Until public attitudes become more understanding, it will be difficult for utilities to again consider new nuclear units. With the lack of a strong national consensus in favor of nuclear power, the fact that, under present conditions, the construction period for a nuclear plant is likely to span three presidential administrations, six Congresses and numerous changes in state and local government leaves nuclear units singularly exposed to political risks.

[+] In January 1984, the Atomic Safety and Licensing Board rejected Commonwealth Edison's bid for an operating license for Unit 1 of its Byron project. This was the first time such a drastic step had ever been taken in the 27-year history of the civilian nuclear industry. ASLB cited numerous construction problems, largely related to quality assurance, as the reasons for their action. Commonwealth Edison appealed the decision and hearings on the appeal were held during July and August. In October, 1984, ASLB reversed their earlier decision and rendered a decision favoring the granting of a license.

In any assessment of the history of nuclear power it would be wrong to suggest that the utilities or the architect-engineers and nuclear suppliers have been blameless or that all of the problems of nuclear power arise from deficiencies of law and regulation and the activities of nuclear opponents. Such is not the case. Like any companies launching a complex new technology, the developers of nuclear power have made errors and misjudgments. In some cases they failed to appreciate the complexity of nuclear power and to respond adequately to the demands it poses.

But those deficiencies are not adequate to explain why the entire industry has turned away from nuclear power or why even companies confident in their own abilities in construction and nuclear operations will shun nuclear orders.

IV. THE CASE FOR REOPENING THE NUCLEAR OPTION

The United States should begin now to take steps that will again make nuclear power an option that utilities will consider to meet future needs for electric generating capacity.

We do not advocate this because utilities are somehow devoted to nuclear power per se. Electric utilities are not, and should not be, attached to any particular technology or mode of operations. Rather, their attachment is to the goal of providing the reliable electric service America needs at the lowest possible cost. This goal is not only essential to providing all of our citizens a good standard of living; it is also vital to the continuing ability of American business to compete with foreign producers in our own and foreign markets. We do not want to build into our system higher than necessary costs for energy.

To achieve our goal, utilities must make unbiased choices among the available means of supplying electricity or reducing electricity demand, as discussed in Chapter 2 above. And it is in the national interest to foster the development and commercial availability of all of the options that can be cost competitive in meeting electricity demand. Of course all of the competitive options would have to meet the standards of safety and environmental protection that society establishes.

In a reformed regulatory and institutional setting, nuclear power can again be one of several viable options for utilities in the United States. The conditions that now make new nuclear orders unattractive to utilities are not inherent in the technology but result from the ways in which nuclear power has been regulated by our government and managed by our industry.

The reasons for believing that nuclear power can again be competitive for utilities are found in the experience of many operating nuclear units in the United States, in economic analysis and in the continuing development of nuclear power in other countries.

The Record of Existing U.S. Nuclear Units

The problems of excessive cost and risk associated with a number of nuclear units built and building in the 80s should not obscure the fact that the majority of the U. S. nuclear units were built at reasonable cost, have operated with a high level of safety and are generating electricity at a lower cost than any other option currently available. The 76 nuclear units that operated in the United States in 1983 generated 12.6 percent of the total U. S. electricity supply. That represented more electricity than the entire national output of electricity in 1945.

The units built in the early 70s have a capital cost of about $300 per kilowatt. While events since their construction have increased their operating costs, their fuel costs were little affected by the surge in world fuel prices in the 70s. As a result, these units are generating electricity at total production costs -- including capital, operating and maintenance expenses, fuel and provision for waste disposal and decommissioning -- of 1, 2 and 3 cents per kilowatt hour. The cost of electricity from these units is generally lower than from any generating units other than old hydroelectric units. These units illustrate very well the advantage that nuclear power provides when fuel prices rise significantly.

Furthermore, some of the units built and being built in the 80s will also be competitive with the least costly alternative. Units such as McGuire 2 with an expected cost of $930 per kilowatt illustrate nuclear power's continuing potential to be cost competitive. If there were reasonable assurance that any new nuclear unit could be built at the cost of the least expensive of the units built in the 80s, utilities would still consider nuclear power as an available option for the future -- subject to a clear determination that additional capacity was needed, to regulatory treatment that would permit the construction of any central station generating capacity and to convincing evidence that facilities for the disposal of nuclear wastes will be available.

Economic Analyses

Economic analyses continue to indicate that nuclear power can produce electricity at lower costs than coal units equipped with flue gas scrubbers in some areas of the country.

One recent study[+] shows that if nuclear construction costs, in inflation-adjusted dollars, are kept within limits ($1290 to $1727 per kilowatt in 1982 dollars) that have been achieved in the past and are clearly technically feasible -- and assuming 7 percent inflation, debt costs of 10.4 percent, a 60 percent nuclear capacity factor, and a one percent annual rate of increase in real (inflation-adjusted) coal prices -- nuclear power will provide savings to customers over the life of the units in seven of nine regions of the country. In five of the regions the cost of nuclear generated power is estimated to be 10 to 20 percent less than coal. In two regions the nuclear advantage is small and in two regions coal is expected to have an advantage.

[+] Lewis J. Perl, The Economics of Nuclear Power (National Economic Research Associates, New York, New York, 1982)

This result, of course, depends crucially on having nuclear construction costs at reasonable levels. And that in turn cannot be achieved unless, among other things, the units can be completed and placed in operation in a reasonable period of time. Even if that is accomplished, the relative cost of the two options would be affected by other uncertainties. Higher inflation rates and real debt costs, and lower nuclear capacity factors and coal prices, would erode or eliminate the cost advantage for nuclear power. Conversely a shift of these factors in the other direction would increase the benefit of nuclear units.

Another study+ comparing nuclear and coal units that would come into service in 1995 concludes that nuclear units would have a significant cost advantage in two regions, coal units would generate less costly power in two regions, and the cost of electricity from the two options would be about equal in the rest of the country. That conclusion is also sensitive to the assumptions that were used. Those assumptions include nuclear construction costs that have been achieved in the past but are below the average for the current generation of units.

Studies such as these cannot be definitive. But they strongly suggest that at attainable levels of construction cost, nuclear units could be advantageous in the future as they have been in the past.

Foreign Nuclear Development

In other countries around the world, both private utilities and government power agencies are continuing to order new nuclear units. In the period since 1978 when no new orders for nuclear units have been placed in the United States,

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+ Energy Information Administration, U. S. Department of Energy, Projected Cost of Electricity from Nuclear and Coal-Fired Power Plants (Washington, D.C., 1982)

26 orders for new nuclear units have been placed in France, West Germany, Great Britain and Japan and 15 in the rest of the world.

In France, 13 new reactors were ordered between 1979 and 1983 and orders are continuing at the rate of two per year. Nuclear power is already providing more than half of France's electricity supply and is expected to provide about 83 percent by the year 2000. The French nuclear program is based on standardized designs that allow units to be completed in less than six years and with relatively low capital costs. While the French have also experienced increases in the real (inflation-adjusted) cost of nuclear construction, these increases have been relatively modest. As a result, French authorities estimate that the total cost of electricity generated with nuclear units is now 20 to 40 percent less than electricity from coal-fired plants.

In Japan, where power plants are constructed by private utilities rather than a single government agency as in France, 11 nuclear units have been ordered since 1978. By 1985, nuclear power will provide about 23 percent of the Japanese electric supply. As in France, the construction periods are relatively short, with some units completed in 4½ to 5 years. Construction costs per kilowatt are substantially below those in the United States.

In the Federal Republic of Germany, one new nuclear unit was ordered in 1981. It and four others ordered earlier began the complex licensing process in 1982. While Germany has been less successful than France and Japan in keeping construction periods short, government and industry experts still consider nuclear power cheaper than electricity from new coal units. Like Japan, West Germany will get about a quarter of its electric supply from nuclear units in 1985.

In France, Japan and West Germany, the nuclear units being built are, for the most part, variants of the light water reactor technology developed in the United States. However, in all three countries the number of engineering and construction man-hours utilized per kilowatt of capacity built is substantially less than in the United States.

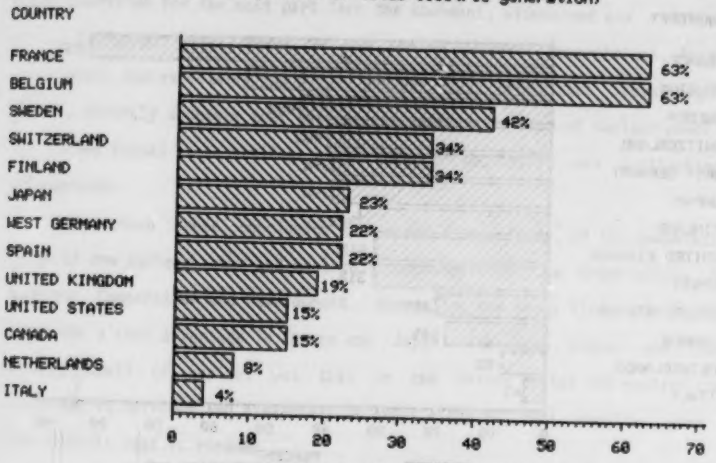
In Britain, the future of nuclear power is currently the subject of an extensive inquiry concerning plans for development of as many as seven light water reactors. The 32 reactors now operating or under construction in Britain are gas cooled or advanced gas cooled units. The installed generating capacity of the Central Electricity Generating Board is ample and demand growth is projected at only about one percent annually. The new nuclear units are therefore proposed as a means of reducing costs by phasing out older coal-fired units and moving the country away from its current reliance on coal for 80 percent of its electricity supply.

The development of nuclear power overseas has been subject to some of the same factors operating in the United States: slower growth in electricity demand, inflation and high interest rates, challenges by opponents of nuclear power and concerns over safety. Yet in these four economically advanced and technologically sophisticated countries decision-makers have continued to opt for nuclear power. These are countries more dependent than the United States on international trade and therefore necessarily concerned with the effect of energy costs on their competitiveness. Of course, factors other than relative cost -- such as energy security, balance of payments effects, jobs and industry policy -- may enter into their choice of generating technologies.

The following charts show projections by the Organization for Economic Cooperation and Development of the shares of national electricity generation to be provided by nuclear power in the United States and 12 other OECD member countries in 1985 and in the year 2000.

CHART 6

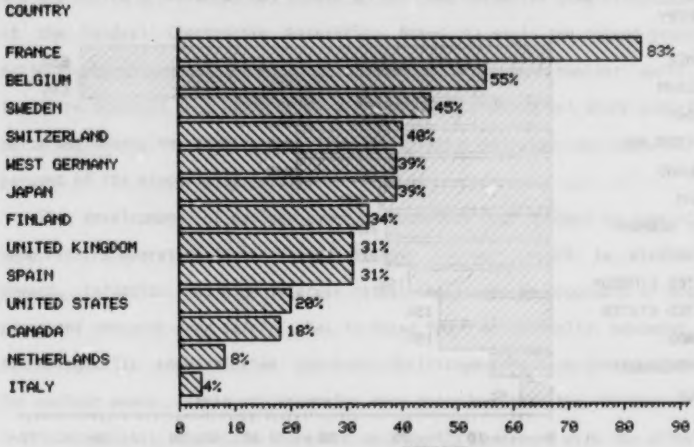
PROJECTED NUCLEAR SHARE OF ELECTRICITY GENERATED, 1985
(nuclear as a percent of total electric generation)



SOURCE: ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT NUCLEAR ENERGY AGENCY, PARIS.

CHART 7

PROJECTED NUCLEAR SHARE OF ELECTRICITY GENERATED, 2000
(nuclear as a percent of total electric generation)



SOURCE: ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT NUCLEAR ENERGY AGENCY. PARIS.

Foreign experience indicates that nuclear power plants, similar to those used in the United States, can still be built at costs far below those currently prevailing in the United States.

The apparent competitiveness of nuclear power overseas does not automatically mean that it should be competitive in the United States. The other countries for the most part lack the abundant, widespread and relatively cheap indigenous coal found in the United States. Nevertheless, foreign experience, and especially the large nuclear cost advantages prevailing in France, strongly suggests that the current unattractiveness of nuclear power in the United States is an artifact of our peculiar regulatory and institutional arrangements.

This common sense conclusion is supported by a study[+] of the comparative costs of new nuclear power and coal units undertaken by the Organization for Economic Cooperation and Development. Generally, the study finds that nuclear power has a cost advantage in Europe and Japan with both higher and lower assumed costs of capital but that in the United States the nuclear cost advantage is narrower and disappears in areas close to coal supplies when a high capital cost is assumed.

Expanding Generating Options

An object of reforms in the way nuclear power is regulated and managed in the United States would be to lower its costs. The evidence cited in this chapter suggests that very substantial cost reductions are possible. Such cost reductions should be pursued as far as safety and the nature of the technology will allow.

[+] P. Silvennoinen, "An International Comparison of Nuclear and Coal-Fuelled Electricity Generation Costs", (OECD Nuclear Energy Agency, Paris, 1984)

Cost reductions that again give new U. S. nuclear units a cost advantage over coal units in some circumstances and areas would be desirable. However, they would not necessarily make nuclear power the option of choice for utilities. New coal units equipped with flue gas scrubbers have themselves become very costly. The issue for utilities goes beyond whether nuclear or coal units will generate the least costly electricity. It is also whether either nuclear or conventional coal units will be cost competitive with other supply and demand-reducing options.

The electric utility industry would like to be able to meet the capacity needs of the 1990s with units that will generate electricity at lower costs in constant (inflation-adjusted) dollars than either the new coal or nuclear units of today. Theoretically that can be achieved by developing new generating technologies and demand-reducing programs that have relatively low costs as well as by reducing the costs of new nuclear and coal units.

From that perspective, efforts to reform the regulation and management of nuclear power are not different in their objective than the research and development designed to prove out new generating technologies. Both of these efforts would enhance the electric utility industry's ability to meet future needs for generating capacity at the lowest possible cost. In the national interest, both of these efforts should be pursued vigorously.

V. AN AGENDA FOR INSTITUTIONAL AND REGULATORY CHANGE

Now is the time for America to take a longer term view of its electricity needs and how they can best be met.

To recapitulate the present situation:

* The electric utilities now face significant economic and political disincentives to make new investments.

* The industry projects growth of demand of 2.5 percent annually -- about the actual growth in the period since the Arab Oil Embargo. Projections by non-utility analysts range from less than one percent to 5 percent.

* At growth rates as low as 2 percent, capacity margins would be down to minimum levels required for system reliability by the mid 90s. With variations in regional growth rates, physical limitations on the transfer of power between regions and possible new environmental controls, the need for additional capacity would emerge earlier in some regions.

* If new generating capacity is to be provided by conventional coal units, construction must begin years before the plant is needed. With modest demand growth, this would require utilities to make commitments to new capacity in the mid to late 80s.

* But utilities are caught between their lack of incentive to invest and their obligation to provide adequate service to their customers. This dilemma is the result of economic regulation that is in conflict with itself.

* Public policies are proposed and sometimes adopted on the outdated theory[+] that utilities profit by adding capacity whether it is needed or not and therefore must be restrained from excessive building. Today's surplus of capacity is cited as proof of that proposition as though the energy discontinuities of the 70s had never occurred.

* If generating units that are economical for producing large amounts of electricity will not be available when they are needed, the shortage -- both in prospect and in ultimate realization -- would have dampening effects on economic growth. It would discourage productivity improvements that can be achieved through increased use of electricity. And it would also require stopgap measures in which units that could be built quickly -- such as combustion turbines -- would be installed despite their exorbitant operating costs. It would increase the use of oil and gas fired units, raising costs and undermining the national interest in avoiding excessive dependence on foreign oil supplies. Although we would hope that service disruptions and rotating blackouts would be rare, they also would be a possibility.

* Conservation and load management measures in addition to those already included in utility programs have a role to play in meeting future demand growth. The achievable additional demand reduction will postpone but can not eliminate the need for new generating capacity.

[+] The so-called Averch-Johnson effect held that, because under regulation utility revenues are determined by applying a return on capital to the utility rate base, utilities would seek to increase profit by investments that added to the rate base. But that incentive can not be operative in a time when authorized and earned returns on capital are below the cost of capital to the utilities.

* No utility will again order a nuclear unit under the present regulatory and institutional setup. That leaves the utilities with only one proven possibility for providing baseload generating capacity -- coal-fired units. A number of promising new technologies are under development but none has yet been proven suitable for providing large amounts of power at a competitive cost.

* Today's interest in nuclear power is focused on the troubled plants now under construction with little regard for the role that nuclear power will play, or under present conditions will not play, in America's energy future.

In our judgment, the United States is on a course that is full of peril. Our country has drifted into a de facto electricity policy that it would not deliberately choose. But if we can soon adopt policies shaped by a long-term view of our electricity situation, it is not too late to avert serious damage to our economy.

We recognize that our assessment will be challenged as self-interested. We offer it not with the expectation that it will be accepted but rather with the hope that it will prompt a process of evaluation that will be generally regarded as realistic and unbiased. What the nation needs now is not more controversy but a step toward consensus and the development of conclusions that can guide the actions of the Federal and state governments and of the industry.

A National Commission on Electricity

To that end, we recommend the early appointment of a National Commission on Electricity. The Commission should consist of a small and expert group of distinguished Americans. It should make judgments on the future growth of electricity demand and the means by which any need can be met by both reductions in demand and increases in supply. If it finds that additional generating capacity will be needed, it should consider the circumstances under which it would again become economically rational for utilities to make major capital investments and the generating options that should be available. It would recommend policies which flow from its judgments on those issues. The Commission should complete its study expeditiously and make its report to the President and Congress within six months.

The Commission cannot eliminate the uncertainties related to future electricity demand and supply. But it can and should examine the different costs and risks of having too much or too little generating capacity and decide how best to handle those risks. Specifically, current political and regulatory policies are primarily oriented toward protecting society against the risk of having too much capacity. The Commission should decide whether that orientation is now, and in the future, in the public interest. Studies[+] cited previously have found that the social cost of having a shortage of capacity is five times greater than the cost of an equal excess of capacity.

The issue of the generating options that should be available arises only if there is a clear need for additional generating capacity and if the utilities are no longer constrained to follow a policy of minimizing their capital investments.

The conditions that would remove the current disincentive to utility capacity additions are these:

* earnings that equal the market cost of capital needed for the new capacity and utility stock prices at least equal to their book values;

* sufficient cash flow through earnings or through a consistent provision for current recovery of construction carrying charges to maintain reasonable financial ratios and a strong bond rating, and

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[+] See page 23

* restoration of a reasonable relation between risk and reward by providing that all prudently incurred costs will be recovered or by allowing appropriate risk premiums.

Electric utilities are no longer willing or able to embark on major construction projects that threaten them with financial ruin. The recent improvement in the financial health of a large part of the electric utility industry should not be confused with a resolution of this problem. The financial improvements are strongly correlated with the completion or winding down of current construction programs. The fact that utilities may be able to gain in financial health when they stop building does not mean that they could remain in financial health with major new construction commitments.

Once the issue of generating options is reached, we believe, for the reasons stated in Chapter 4, that nuclear power should be among the options available to utilities.+ If the Commission also reaches this conclusion, it should recommend the far-reaching changes by both the industry and government that will be needed for utilities to again consider ordering nuclear units.

These changes should have four major objectives:

* to enhance both the reality and the perception of the safety of nuclear power;

* to reduce constant-dollar (inflation-adjusted) construction costs of nuclear units and make them more predictable and, to shorten nuclear construction periods to the durations achieved now overseas and formerly in the United States;

+ This paper is focused on conventional nuclear reactors and does not consider breeder reactors, the need for which has receded into the more distant future. Uranium supplies are clearly sufficient to fuel the conventional reactors that would be built if nuclear power again becomes an attractive option for utilities. However, research and development on breeders should continue since that technology can provide an essentially inexhaustible supply of energy when needed.

* to improve construction quality, and

* to eliminate needless risks that a new nuclear unit will be unable to operate.

Many of the necessary steps must be taken by the electric utility industry and its suppliers. Most of these steps will require acquiescence or support by the Nuclear Regulatory Commission and the relevant economic regulators.

Actions by the Industry

First and foremost, **the electric utility industry must maintain excellence in the operation of its existing nuclear units.** The industry has been working toward that objective both by strengthening nuclear operating organizations and staffs within individual companies and through industry-established groups: the Institute of Nuclear Power Operations (INPO), the Nuclear Safety Analysis Center (NSAC) and the Electric Power Research Institute (EPRI). EPRI has major research and development programs to improve the safety and reliability of the present units and NSAC is continually evaluating operating experience to advise the utilities on measures that can lessen the risk of accidents. INPO, which was established following the accident at Three Mile Island, is dedicated to assuring that the best operating practices are followed throughout the industry. INPO is engaged in reviewing, analyzing and communicating information and recommendations concerning operating problems. It also makes periodic inspections to determine whether its recommendations have been carried out, to identify shortcomings and to evaluate utilities' operating performance. INPO has established criteria for the training of nuclear plant personnel and evaluates training programs leading to accreditation. The response by utilities to INPO's recommendations and reviews has been, and must continue to be, excellent. These industry efforts are in addition to reviews and requirements of the NRC.

Operating nuclear units is a complex and demanding activity requiring a broad range of expertise and substantial resources devoted exclusively to nuclear operations. While many nuclear units operated by small companies or companies with only one unit have excellent operating records, mechanisms to aid or consolidate small nuclear operations should be considered. The possibilities include the provision of support services by companies with larger nuclear operations, the establishment of nuclear operating companies that would contract to operate the units of a number of small or single-unit companies, the establishment of separate nuclear companies to acquire the nuclear operations of small or single-unit companies and finally the merger of such companies. Experience has demonstrated that the construction and operation of nuclear units requires very large resources. That fact is likely to limit any future development of nuclear power to large companies or consortiums.

As part of excellent operating performance, **the industry must continue its record of safety in which not a single member of the public has been killed or injured in the course of more than 800 reactor-years of operation.** The accident at Three Mile Island resulted in the release of a small amount of radiation that in the estimate of the Kemeny Commission appointed by President Carter would most probably result eventually in between zero and one cancer death. Subsequent research by the National Research Council/National Academy of Sciences suggests that even that estimate was too high. While these findings are no cause for rejoicing, and the industry is bending every effort to prevent accidents in the future, the accident usually described as the worst in the history of commercial nuclear power in fact resulted in no major harm to public health or safety. Nevertheless it is important, both practically and psychologically, that the damaged reactor at Three Mile Island be cleaned up and its undamaged twin be allowed to resume operation.

The industry can enhance the value of existing units and the prospects for new units by increasing the amount of electricity generated in relation to the amount that would be produced if the units ran constantly at full rated power. This relationship is known as the "capacity factor". The types of reactors used in the United States must be taken out of operation periodically for refueling as well as for routine maintenance. Their capacity factor is inherently well below 100 percent. However, the actual cumulative capacity factor of U. S. units is only 59 percent. To some extent this is the result of plant modifications required by the NRC -- so-called "backfits" which are discussed below -- and other factors beyond the utilities' control. However the performance of the better U. S. units suggests that there is scope for the industry to raise the average capacity factor. It should do so.

Institutional Changes

Second, **the industry must undertake a number of institutional changes to pave the way for the development of new nuclear units.**

The industry must adopt and present for licensing standard designs for new nuclear power units.

The advantages of a standard design are numerous. It would simplify plant licensing. It would allow the accumulation of expertise in repetitive construction activities. It would improve quality control and allow greater factory production of plant components. It would facilitate training of operators and maintenance staff and make it easy for utilities to learn from the operating experience of others. The result of these advantages should be shorter planning and construction periods, reduced construction costs and improved unit operations.

The standard designs should be advanced versions of the pressurized water reactor and the boiling water reactor generally used in the United States.

This approach would build on the extensive operating experience with light water reactors in the United States and around the world. It would allow the systematic incorporation of features that would increase the safety, reliability and longevity of the new units.

While redundant safety systems in existing reactors make the probability of an accident affecting the public extremely low, many people are worried about nuclear safety. Design changes that would measurably reduce the already low risk of nuclear power could help win public support for new nuclear development. A fresh approach to light water reactor design would allow the integration and simplication of features added piecemeal to earlier units. By incorporating additional passive response mechanisms, it should be possible to increase the time available to respond to operating problems and to reduce the need for active intervention by the plant's operator. Both the industry and government should support research and development on safety features and their incorporation in new designs.

Improvements in unit availability can be achieved by design improvements that would reduce the amount of operating time lost for refueling and repairs. The new reactors can be designed for longer periods between refuelings. The new designs can incorporate systems and materials that facilitate maintenance. They can utilize new and better ways of accomplishing safety objectives. For example, safeguards against piping ruptures in the event of an earthquake can be achieved without the use of a myriad of shock absorbers -- known as snubbers -- that periodically require time-consuming inspection and repair.

The resulting increases in unit availability would, of course, tend to improve the cost competitiveness of nuclear power.

Lessons concerning the effects of operating conditions on materials and systems can be applied to design the new reactors for longer life. With the relatively high capital cost of nuclear units, such increases in longevity can significantly reduce the life cycle cost of nuclear power.

Use of standard designs can also improve construction quality by facilitating the fabrication and installation of major elements of the plant and by allowing better scheduling of construction activities based on a fully completed design.

The adoption of standard designs does not mean that technology would be frozen for all time. Rather, research and development would continue, both on light water reactors and on alternative reactor types. Periodically a new standard design would be adopted that would reflect the accumulated advances in nuclear technology. Whether the new standard designs of the more distant future would embody continued improvements in light water reactors or, at some point, be based on an alternative reactor type will depend on technological developments that cannot be foreseen.

The industry should prepare to make greater use of separate nuclear companies and joint ventures as a means of spreading the risk associated with any particular unit and allowing the addition of capacity in increments that closely match demand growth. Even with standardized designs allowing for shortened lead times and lower construction costs, individual utilities may be reluctant to embark on new nuclear construction by themselves.

The financing burden for a single company will still be large. And even for relatively large companies, nuclear units of the most efficient size will provide an amount of additional capacity that will become needed only over several years. Those disadvantages can be reduced or eliminated through joint ownership. The use of nuclear companies and joint ventures can also have the added advantage of allowing a valuable accumulation of construction expertise that can reduce costs.

However, the potential value of joint ventures depends critically upon firm, long-term commitments not only from participating utilities, but from their regulatory commissions as well. The development of new joint construction efforts can proceed only in an atmosphere of clear understanding that such commitments are needed and strong confidence that they will be strictly honored.

Future contracts for nuclear plant construction will have to incorporate a reasonable allocation of the risks of cost increases among the electric utilities and their suppliers and architect-engineers.

This allocation could range from fixed price contracts for the development of elements of the plant to provisions for cost escalation subject to caps or incentive systems. The allocation of cost risks would necessarily be linked to the allocation of responsibilities for managing the project and the ability of the parties to control the costs.

Public Attitudes

The industry should maintain a strong program to educate the public about nuclear power because without public support the changes required to permit further development of nuclear power are unlikely. As it is now, the public continues to be concerned about the risk of nuclear power. This is combined with the perception that new nuclear units -- and indeed any major new generating units -- are unneeded. And reports of high cost units have made a more vivid impression than the little-reported performance of the units generating low cost electricity.

At present a number of organizations are engaged in various efforts to communicate with the public directly and with the media on behalf of nuclear power. These efforts need to be better coordinated and focused on issues that are crucial in determining public views.

When the public perceives the need for additional generating capacity and understands that alternative power sources such as solar systems and wind turbines will not meet the nation's need by themselves, it should know of the record of nuclear power and of the reforms by the industry and government that can make new nuclear units even safer and once again economical. Those conditions will provide the basis for a positive shift in public opinion concerning nuclear power.

Reforms in Government Policy

Major reforms in government policy affecting nuclear power must go hand in hand with changes in the industry.

The NRC should approve standardized plant designs and promptly license new units that are proposed to be built according to those designs. Standardization should aid in safety regulation because it will be far easier for the NRC and other interested parties to thoroughly analyze and understand one or two standard designs than an ever-changing variety of customized designs. Unlike past practice, the full design would be known before the first shovel was turned. Given the complexity of nuclear plants, that advantage can be of great importance.

Licensing based on standardized design should be coupled with advance approval of nuclear plant sites. Only the limited design modifications needed to accommodate the standard design to a particular site would need to be considered by the NRC at the time of licensing. There would be ample opportunity for public participation in the consideration of the standard design and in advance site approval proceedings. Issues settled then would not be revisited in the licensing proceeding unless there was substantial evidence of new information affecting safety that could not have been considered previously.

The result of these provisions should be to considerably shorten the licensing process with an enhancement of safety regulation and opportunity for meaningful public participation.

Standardization necessarily implies a limitation on "backfitting" requirements. Numerous requirements for modifications to plants under construction and existing plants can quickly wipe out many of the advantages of a standard design.

The present NRC practice concerning backfitting is chaotic and the Commission, recognizing the problem, has itself initiated a proceeding aimed at reforms. While the outpouring of requirements that followed the Three Mile Island accident has subsided, numerous new requirements are still under consideration by the NRC staff. There are now about 90 rulemaking and 60 safety issues pending before the NRC that, according to one expert, could require additional expenditures of between $100 million and $200 million at each existing nuclear plant. While the backfit requirements are adopted in the name of safety, there is a real danger that the continuing piecemeal modifications of complex systems will actually make them less safe as well as less reliable.

A standard should be adopted and enforced that would rule out backfits unless they would clearly produce a substantial benefit to the public safety and health. The NRC should adopt, or be required to adopt, clear criteria governing backfits, and the costs and benefits of proposed new requirements should be considered even if they cannot be precisely quantified. Furthermore, the NRC should adopt organizational or procedural changes to foster fairness and uniformity in the enforcement of requirements.

Another needed reform is the establishment of a one step licensing process. All of the issues related to the construction of a nuclear unit should be considered and resolved before construction is permitted to begin. In place of the existing two-step licensing process, a single license should be issued to construct and operate the unit if it is built in accordance with the approved design. When construction was complete, the NRC would simply certify that the unit as built conformed to the approved design and to any modifications approved or required since the permit was issued. It would also determine that the unit met all applicable quality standards.

The NRC's ability to make the required determinations should be strengthened by increased inspections throughout the construction period. As it is now, the NRC is often required to evaluate allegations of construction deficiencies made months or years after the construction was completed. Instead, NRC inspectors should examine key construction as it is completed and determine then and there whether it meets all requirements. With those policies, the public interest in assuring the adequacy of nuclear construction would be protected while the risk of costly delays and the possibility that a completed plant could not operate would be greatly reduced.

Procedures for public hearings should be revised to make the proceeding less like a trial and more like a legislative hearing. In this format, testimony and evidence would be presented first in written form. Only those issues which involved substantial factual disputes that required the introduction of evidence would be tried. Further, **the hearings should be limited to issues supported by substantial facts and should exclude issues not related to nuclear safety and those resolved in other NRC proceedings.**

This reform in the hearing process would place increased reliance on the resolution of generic issues in rulemaking proceedings by the NRC and on technical review of applications by the NRC staff and by the Advisory Committee on Reactor Safeguards. It would place the consideration of policy and technical issues before far more competent and appropriate forums than a licensing hearing.

The appropriateness of a proposed reactor site should be fully considered when the site approval is sought. Any evidence from local governments or others as to the suitability of the site should be evaluated at that time. But once a site is approved and a nuclear unit is built on it, the utility should be able to put in place an emergency plan adequate to protect the public health and safety and to fulfill NRC requirements. Federal law should require the necessary participation in the emergency plan by local or state governments or empower the utility to perform functions pursuant to the plan that would normally be carried out by governments. Of course, it is now and will remain in the interest of the utilities to achieve, wherever possible, a close cooperative relationship with local and state governments in the development and implementation of emergency plans.

A number of studies are currently underway to reassess the amount of radiation that might be released in the most serious accidents. If those studies find that the radiation risk to the public in the most serious type of accident is substantially less than previously estimated, the importance of the nuclear emergency planning and the need to provide for possible evacuations would diminish.

The Nuclear Regulatory Commission should be structured to better carry out its complex duty of managing a comprehensive nuclear safety program. It is clear that the Commission-type organization as currently administered by NRC does not result in an efficient and effective decision-making process. One problem is that the NRC Chairman does not have the full range of authority provided by law to the chairmen of most other Federal regulatory agencies and those usually associated with the role of a chief executive officer. Another problem is the need to accommodate in a commission-type structure a diversity of views. The NRC Chairman has recommended abolition of the Commission in favor of a single administrator, a recommendation earlier made by the Kemeny Commission and the Rogovin Special Inquiry. Others have recommended a strengthening of the authority of the Chairman, or, alternatively, of the executive director for operations. We recommend that the National Commission on Electricity investigate the reasons for the current situation and make appropriate remedial recommendations, including, if necessary, a change in the NRC's form of governance.

One of the important sources of public concern about nuclear power has been fear that highly radioactive nuclear wastes can not be disposed of safely. In fact, nuclear waste disposal has been and is a political and institutional problem, not a technical problem. The United States took a major step toward its resolution with the passage of the Nuclear Waste Disposal Act in 1982. That legislation established a well-defined program with a schedule for the accomplishment of intermediate and final goals. The crucial issue now is whether the Act will be implemented and its goals achieved on the prescribed schedule. The Act provides for the establishment of the first repository for permanent disposal of highly radioactive waste by 1998 and the Department of Energy has contracted with utilities to accept waste for disposal at that time. To build confidence that those commitments will be fulfilled, major steps toward creating the repository must be accomplished essentially on schedule. One of these is the President's selection in 1985 of three possible sites of a repository for further study.

The Act is structured to provide for the involvement and consideration of all of the affected parties and to provide mechanisms for resolving conflicts. Yet the forces for drift and delay which prevailed in the past remain strong.

It is incumbent on the Administration and the Congress to prevent them from reasserting themselves and undermining the effectiveness of the Act.

Underlying the implementation of the Act should be a recognition that the nation will be far better off with permanent nuclear waste repositories than with the continued accumulation of highly radioactive spent fuel in power plant spent fuel pools and other interim storage facilities.

By the time utilities might again be in a position to consider new nuclear orders, they will need to see clear and convincing evidence that permanent nuclear waste disposal facilities will be created. Without that assurance, they will not order new nuclear power plants.

The nation must also get on with the job of providing orderly arrangements for the disposal of low-level nuclear wastes. These materials, which lose their radioactivity relatively quickly, come not only from electric utilities but from medical facilities and laboratories, industries and government.

The Low-level Radioactive Waste Policy Act of 1980 placed responsibility for disposal of low-level wastes on the states, authorized them to form regional compacts for that purpose and permitted the compacts, beginning in 1986, to exclude waste from other regions. However, implementation of the program has bogged down.

Congress should move ahead by approving uniform compacts as called for in the 1980 legislation, but with provisions allowing continued access to existing disposal facilities by regions without such facilities for no longer than needed to allow them, with good faith efforts, to establish their own disposal sites.

Congress should also extend the Price-Anderson Act of 1957 with the continuation of a cap on utilities' total liability. The Price-Anderson Act provides substantial benefits to both the public and the utilities.

For the public, the Act provides a large fund in addition to available private insurance to pay possible claims for injuries or damages resulting from the operation of nuclear plants. This fund would be created by an assessment on each utility operating a nuclear reactor if damages ever exceeded the $160 million of insurance carried by the company against which the claims were made. The Act also establishes an efficient system for handling all claims and fixes responsibility squarely on the nuclear operators. And, in the event of an accident with substantial effects beyond the plant site, the Act requires utilities to waive defenses to which they would otherwise be entitled. Without those provisions, recovery of any damages would be complicated, uncertain and protracted.

For the utilities, the Act provides a limit on their total liability for injuries and damages related to nuclear operations. This limit eliminates an open-ended business risk that utilities planning the development of new generating capacity would not be willing to accept and that some companies with existing nuclear units might not be able to bear. It also avoids substantial risk premiums that would otherwise be applied by investors and by companies engaging in nuclear construction and supply.

The cap on utility liability and the benefits to the public provided by the Price-Anderson Act must continue to be linked. The Act has been and remains an effective and equitable approach to a situation in which there is no loss experience to provide a basis for exclusive reliance on private insurance. As noted previously, there has never been an accident that resulted in substantial radiological effects beyond a plant site.+

+ See page 55 above. Payments for emergency evacuation expenses, business losses, lost wages, and other damages related to the accident at Three Mile Island are expected to be fully covered by the private insurance carried by the plant's owner.

At the very time that it is necessary to reduce costs and risks in an effort to regain the potential benefits of nuclear power in the United States, removing limits on liability would move decisively in the wrong direction. It would help to assure that no new orders for nuclear units will be placed in this country in the future. Furthermore, for utilities with existing nuclear units, action that essentially removed limits on total liability, while retaining the provision for waiver of defenses, would be an inequitable and possibly unconstitutional change in an arrangement the companies relied upon in choosing to build nuclear generating units.

CONCLUSION

With economic growth, the United States will need substantial amounts of additional electric generating capacity in the 1990s. Even if recent construction periods for generating units are reduced, the development of economical new generating capacity will still require a number of years. It is therefore timely now to begin taking the steps that will make it possible for America's electric utilities to serve future electricity demand fully and at the lowest possible cost.

This requires first and foremost the creation of a national consensus on the need for generating capacity. From that consensus must flow changes in the economic regulation of utilities that will again make it economically rational for utilities to build.

Nuclear power is inherently capable of playing an important role in meeting future needs for economical generating capacity, and thereby contributing to the vitality and competitiveness of the American economy. But it cannot do so without comprehensive reforms in current Federal laws and regulatory practices and in the policies and practices of the electric utility industry and its suppliers. With such reforms, nuclear power could again become an option that utilities could consider in their efforts to serve their customers at the lowest possible cost.

Recent experience with nuclear construction has been such that before new nuclear units are ordered in the United States utilities, investors and utilities commissions, will want a high level of confidence that conditions will again allow nuclear development to be advantageous to customers and stockholders. Establishing that level of confidence cannot be accomplished quickly but we believe it can and should be done.

The United States is now on a course that will lead to electricity costs that are higher than necessary and to losses of jobs and income and economic growth.

There is still time to change direction and avoid those damaging results. To do so, we must have the wisdom to look ahead, to understand what our situation requires and to act realistically on that understanding.

# # #

SOUTHWEST REGIONAL ENERGY COUNCIL
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CHAIRMAN
SEN. W.D. MOORE, JR. (AR)

EXECUTIVE DIRECTOR
PATRICK J. RAFFANIELLO

July 28, 1985

Mr. Robert G. Fitzgibbons
Minority Counsel to the Subcommittee
on Energy Conservation and Power
H2-564 House Office Building, Annex II
Washington, D. C. 20515

Dear Mr. Fizgibbons:

Enclosed is a copy of Senator Grant Jones' testimony before the Senate Subcommittee on Nuclear Regulation. I have also enclosed a copy of the testimony submitted for the record.

Senator Jones was testifying in his capacity as past-chairman of the Southwest Regional Energy Council. The Council is an organization of legislators from Texas, Arkansas, Louisiana, New Mexico, and Oklahoma. The testimony was prepared pursuant to a policy statement adopted by the unanimous consent of the member states. Enclosed is a pamphlet describing the Council.

I appreciate the opportunity to submit the Council's testimony to the Subcommittee on Energy Conservation and Power. Please let me know if I can assist you in any way.

Sincerely,

Pat Raffaniello

Patrick J. Raffaniello

Enclosures
xc: Senator Jones

EXECUTIVE COMMITTEE
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TESTIMONY OF TEXAS SENATOR GRANT JONES
BEFORE THE SUBCOMMITTEE ON NUCLEAR REGULATION
JULY 11, 1985

GOOD AFTERNOON. MR. CHAIRMAN, MEMBERS OF THE COMMITTEE, THANK YOU FOR INVITING ME TO TALK TO YOU ABOUT NUCLEAR POWERPLANT LICENSING. I AM SENATOR GRANT JONES OF ABILENE, TEXAS. I AM CHAIRMAN OF THE FINANCE COMMITTEE OF THE TEXAS SENATE. I AM ALSO PAST CHAIRMAN OF THE THE SOUTHWEST REGIONAL ENERGY COUNCIL, WHICH I AM REPRESENTING TODAY. THE COUNCIL IS AN ORGANIZATION COMPOSED OF STATE SENATORS AND STATE REPRESENTATIVES FROM ARKANSAS, LOUISIANA, NEW MEXICO, OKLAHOMA, AND TEXAS. THE TESTIMONY THAT I SUBMIT TO YOU IS UNANIMOUSLY SUPPORTED BY THE COUNCIL MEMBERS OF ALL OF OUR STATES.

I HAVE SUBMITTED SEVERAL PAGES OF PREPARED TESTIMONY WHICH PROVIDES A DETAILED EXPOSITION OF THE EFFICACY AND BENEFITS OF EARLY SITE REVIEW, SITE BANKING, STANDARDIZED DESIGN, AND A STREAMLINED NUCLEAR POWER PLANT LICENSING PROCESS. I RESPECTFULLY REQUEST THAT IT BE ENTERED INTO THE RECORD OF THIS HEARING. WITH YOUR PERMISSION, I WILL TAKE A FEW MINUTES TO OUTLINE THE GIST OF THE COUNCIL'S POSITION REGARDING NUCLEAR POWERPLANT LICENSING.

FIRST OF ALL, I WOULD LIKE TO COMMEND SENATOR SIMPSON FOR INTRODUCING "THE NUCLEAR POWERPLANT LICENSING AND STANDARDIZATION ACT OF 1985", SENATE BILL 836, AND FOR HIS EFFORTS IN THIS AREA OVER THE LAST SEVERAL YEARS. THE SOUTHWEST REGIONAL ENERGY COUNCIL FULLY SUPPORTS SENATOR SIMPSON'S EFFORT TO PASS SENATE BILL 836. - - - - - - - - - -

AS YOU, THE MEMBERS OF THIS COMMITTEE, INVESTIGATE THE ISSUES RELATED TO NUCLEAR LICENSING REFORM, PLEASE BE GUIDED BY THE PREMISE THAT AMERICA NEEDS ENERGY TO MAINTAIN ITS POSITION AMONG THE INDUSTRIAL NATIONS OF THE WORLD. WITHOUT AN ABUNDANT SUPPLY OF ENERGY, WE COULD NEVER HAVE ACHIEVED THE STANDARD OF LIVING WE ENJOY, AND WITHOUT THE CAPACITY TO SUPPLY THE GROWING DEMAND OF THE FUTURE, WE WILL STAGNATE AND PROCEED NO FURTHER.

MOREOVER, WE MUST NEVER FORGET THE LESSONS OF THE 1970S. SHAME ON US IF WE PUT ALL OUR ENERGY EGGS IN A SINGLE BASKET. WE MUST HAVE A MIX OF FUEL SOURCES THAT MAKE US INDEPENDENT OF INTERNATIONAL POLITICAL FLUCTUATIONS.

AN IMPORTANT PART OF ANY RATIONAL ENERGY STRATEGY WILL NECESSARILY INCLUDE THE USE OF NUCLEAR FISSION TO PRODUCE BULK QUANTITY ELECTRICAL POWER. IT SIMPLY IS NOT IN THIS NATION'S INTEREST TO IGNORE THIS IMPORTANT ENERGY SOURCE OR TO LET IT DIE IN A QUAGMIRE OF REPETITIVE LITIGATION, REGULATORY UNCERTAINTY, AND UNWARRANTED ATTACKS BY SELF DECLARED PUBLIC DEFENDERS.

THE TIME HAS COME FOR THE CONGRESS TO PROTECT THE ENERGY FUTURE OF AMERICA BY STRUCTURING AN STREAMLINED PROCESS FOR THE LICENSING OF NUCLEAR POWER PLANTS WHICH WILL ASSURE THAT NEEDED PLANTS ARE COMPLETED IN THE TIME REQUIRED FOR CONSTRUCTION WHILE TAKING INTO CONSIDERATION THE NEED FOR REASONABLE LEVELS OF SAFETY AND PUBLIC PARTICIPATION.

WHILE MANY FACTORS HAVE CONTRIBUTED TO THE DRASTIC REDUCTION IN THE NUMBER OF NUCLEAR PLANTS UNDER CONSTRUCTION, MANY HAVE BEEN CANCELLED BECAUSE OF THE TORTOUS PATH THROUGH THE LICENSING MAZE. EVERY TIME AN ISSUE APPEARS TO HAVE BEEN SETTLED, IT IS RAISED AGAIN AND THE PROCESS REPEATS ITSELF. EVERY TIME A PLANT IS THOUGHT TO SATISFY ALL THE NRC REGULATIONS, GUIDES, POLICIES, AND POSITIONS, ANOTHER IS ISSUED. IT IS HARD TO HIT THE REGULATORY BULLS-EYE WHEN IT CONSTANTLY MOVES. WHAT WE SEEK IS A SYSTEM THAT CAN LICENSE A PLANT WHILE EXAMINING IMPORTANT SAFETY AND ENVIRONMENTAL ISSUES A SINGLE TIME, WILL ESTABLISH A LEVEL OF STATE-OF-THE-ART FOR A PARTICULAR REACTOR AND LEAVE IT ALONE, AND WILL PERMIT THE ESTABLISHMENT OF GENERIC FINDINGS THAT CAN BE ASSUMED FOR ANY PLANT UNLESS SUBSTANTIAL EVIDENCE IS PRESENTED TO SHOW THE ASSUMPTION IS INAPPLICABLE.

PRESENTLY, INTERVENORS OPPOSING THE LICENSING OF A NUCLEAR PLANT CAN RAISE A SINGLE ISSUE AT NUMEROUS STAGES IN THE LICENSING PROCESS. ANY LICENSING REFORM PROGRAM OF VALUE MUST CONTAIN PROVISIONS FOR THE RESOLUTION OF LICENSING ISSUES ONE TIME, WITH SEVERE BURDENS OF PROOF REQUIRED FOR THE REOPENING OF THAT ISSUE AT A LATER STAGE. IF THE LICENSING BOARD DECIDES AT THE CONSTRUCTION PERMIT STAGE, THAT A CERTAIN ISSUE HAS BEEN RESOLVED, IT IS INEFFICIENT AND COSTLY TO FORCE THE APPLICANT TO RESPOND TO THE SAME QUESTION AGAIN. IN FACT THE MOST POWERFUL DILATORY TOOL OF THE ANTI-NUCLEAR ELEMENT IS THE RELITIGATION OF ISSUES AT EVERY STAGE OF THE PROCEEDINGS.

The regulatory problems do not cease even after a nuclear plant has been completed in accordance with the design approved in the construction permit. It has been all too commonplace for regulatory changes to forced on a utility by threats that restart after refueling would be delayed unless some staff position, unrelated to the restart, were implemented. I do not believe this was the intent of Congress when you gave the NRC the authority to promulgate regulations. Constant changes in an accepted design, commonly referred to as "back-fit" must be strictly controlled and restricted to changes that are actually needed to make a substantial improvement in plant safety. In addition, the proposed change should be analyzed to determine whether the cost of implementing the change is justified by the level of improved safety. To spend millions of dollars to realize an insignificant improvement is not in the best interest of anyone, especially the consumers who ultimately pay for the changes.

Congress cannot on its own solve all the problems associated with these licensing problems. The purchasers of nulcear power plants must accept the idea of giving up some of their preferences with regard to custom designs. Hte vendors of nuclear components must work to get acceptance of their designs and resist the temptation of constant modification. The NRC must have the authority and be willing to allocate the resources to approve these standard designs. Your help is desperately needed to clear the obstacles such as anti-trust problems that may be inherent in the concept of standardization, and to provide the statutory restriction to unjustified back-fits and unnecessary litigation.

APART FROM ALL OF THE VALID, AND I BELIEVE PERSUASIVE, ECONOMIC AND SAFETY ARGUMENTS SUPPORTING EARLY SITE REVIEW, STANDARDIZED POWERPLANT DESIGNS, AND A STREAMLINED PERMITING PROCESS, THERE IS ANOTHER POWERFUL REASON WHY THE UNITED STATES CONGRESS SHOULD ENACT THE NUCLEAR POWERPLANT LICENSING AND STANDARDIZATION ACT OF 1985. I BELIEVE THAT A RATIONAL NATIONAL ENERGY POLICY WOULD ENCOURAGE A VARIED MIX OF FUEL SOURCES. NUCLEAR POWER SHOULD BE A VIABLE OPTION FOR ELECTRIC POWER GENERATION. AS A MATTER OF FACT, THE PEOPLE OF THE UNITED STATES, THROUGH THEIR DULY ELECTED REPRESENTATIVES IN THE UNITED STATES CONGRESS HAVE DECIDED THAT NUCLEAR POWER SHOULD BE AN AVAILABLE OPTION FOR THE GENERATION OF ELECTRICITY. THE ATOMIC ENERGY ACT OF 1954, THOUGH AMENDED MANY TIMES THROUGH THE YEARS, SPELLS OUT THE CONGRESSIONAL COMMAND TO THE EXECUTIVE AGENCIES TO PROMOTE SAFE AND EFFICIENT MEANS OF HARNESSING NUCLEAR POWER.

THE DUTY OF THE EXECUTIVE AGENCIES IN OUR FORM OF GOVERNMENT IS CLEAR: THE AGENCY IS TO CARRY-OUT THE COMMANDS OF CONGRESS WITH THE POWERS DELEGATED TO THEM BY CONGRESS. THE CURRENT REGULATORY FRAMEWORK FOR LICENSING NUCLEAR POWERPLANTS FAILS IN ITS BASIC PURPOSE. THE LICENSING PROCESS SHOULD FACILITATE THE CONGRESSIONAL INTENT BY EXPEDITING THE EFFICIENT AND SAFE DESIGN AND CONSTRUCTION OF NUCLEAR POWERPLANTS. INSTEAD, THE CURRENT LICENSING PROCESS IS MANIPULATED BY THOSE WHO OPPOSE ANY USE OF NUCLEAR POWER. THE ADVESARIES OF NUCLEAR POWER HAVE BEEN SO SUCCESSFUL IN DEADLOCKING THE LICENSING PROCESS THAT NO NUCLEAR POWERPLANTS ARE CURRENTLY BEING CONTEMPLATED. AT A RECENT CONFERENCE I ATTENDED, I ASKED THE CHIEF EXECUTIVE OFFICER OF AN ELECTRIC UTILITY THAT IS CONSIDERED ONE OF THE BEST RUN NUCLEAR UTILITIES IN THE NATION, WHAT WOULD CAUSE HIM TO CONSIDER BUILDING A NEW NUCLEAR POWERPLANT. HIS ANSWER WAS SIMPLE AND SUCCINCT. IT WAS ONE WORD: "INSANITY."

I BELIEVE IT IS INSANITY FOR US TO ALLOW SMALL, FOCUSED SEGMENTS OF SOCIETY TO MANIPULATE THE NUCLEAR LICENSING PROCESS TO THWART THE WILL OF THE PUBLIC. IT MAY BE THAT WE AS A NATION WILL DECIDE THAT NUCLEAR POWER SHOULD NOT BE AN OPTION. I BELIEVE THAT WOULD BE THE WRONG CHOICE. BUT WHATEVER THE DECISION, THE CHOICE SHOULD NOT BE MADE IN THE CONTEXT OF A REGULATORY PROCEEDING, RATHER THE CHOICE MUST BE MADE HERE IN THE LEGISLATIVE ARENA.

IN CONCLUSION, I URGE THIS SUBCOMMITTEE TO MAKE THE CHANGES THAT WILL PERMIT THE EXPEDITIOUS LICENSING OF NUCLEAR PLANTS, THOROUGH EXAMINATION OF SAFETY AND ENVIRONMENTAL ISSUES ONE TIME, AND THE LIMITATION OF FORCED DESIGN AND OPERATIONAL CHANGES THAT HAVE A NEGLIGIBLE EFFECT ON SAFETY BUT DRIVE THE COST OF ELECTRICITY EVER HIGHER. I URGE YOU TO FAVORABLY REPORT SENATE BILL 836.

THANK YOU FOR YOUR CONSIDERATION. I WILL BE PLEASED TO ANSWER ANY QUESTIONS YOU HAVE ON THIS SUBJECT.

[Whereupon, at 4:42 p.m., the hearing was concluded.]

NUCLEAR POWERPLANT DESIGN STANDARDIZATION

TUESDAY, DECEMBER 10, 1985

House of Representatives,
Committee on Energy and Commerce,
Subcommittee on Energy, Conservation and Power,
Washington, DC.

The subcommittee met, pursuant to notice, at 11:30 a.m. in room 2322, Rayburn House Office Building, Hon. Edward J. Markey (chairman of the subcommittee) presiding.

Mr. **Markey**. Good morning, ladies and gentlemen, and welcome to the second in our series of hearings on reforming the nuclear powerplant regulatory and licensing system. Today's hearing will focus on the standardization of nuclear powerplant designs.

As I think most of you know, standardization has been frequently touted in many quarters as one of the remedies for the ills affecting the nuclear power industry. Standardization is perceived to be one way of improving the NRC's regulatory system and of improving the safety and economics of plant designs. Indeed, much of the concern that I have expressed about nuclear safety over the years is attributable in part to the failure to standardize.

Each of the nuclear powerplants now in operation is custom designed. Not only is each plant different, but Federal safety regulations are not equally applied or applicable to them. Consequently, some plants are safer than others and many plants pose unique safety problems. The result is a regulator's nightmare.

It is important to recognize that this lack of standardization in this country is no plot, but rather the product of two major forces. The first was a leap in technology. We went from plants of about 100 megawatts to those of 1,000 megawatts in a very short period of time. The second was the interplay of competitive forces in the marketplace which led utilities, greatly encouraged by architect engineers, to prefer customized rather than standardized designs.

As we heard at our last regulatory reform hearing, the result is that today, the future of the nuclear option in our energy mix is far from clear. Having learned that nuclear power is far from a simple business, either technologically or economically, we should be wary of oversimplifying when it comes to standardization. While virtually all interested parties agree with some generalized notion of standardization, my concern is that there is no common understanding of what this term actually means or, more importantly, how it should be implemented.

Before we pay legislative homage to standardization, we had all better have a shared view of what should be done and what can realistically be done. That is the goal of this hearing. The subcommittee needs to learn more about what nuclear powerplant design standardization is intended to achieve, and about how standardization is intended to work.

In particular, the subcommittee is interested in learning, (1) what level of design detail should be required for approval of standardized designs; (2) what, if any, changes in technology and design should be required before the next generation of designs are standardized; and (3) whether standardization requires complete plant designs or whether it can be based on standardized subsystems.

We must also be mindful that standardization is not an end in itself. In my mind, its utility must be linked inextricably with improved safety.

Earlier this year, the Nuclear Regulatory Commission informed the subcommittee that it believed that there exists close to a 50-50 chance of a severe core damage accident at an operating nuclear reactor in the next 20 years. Is this the technology that should be standardized or are there more advanced designs that should be mandated?

One example which we will hear about today is the modular high temperature gas-cooled reactor which could offer significant safety and economic advantages over the current generation of reactors.

On the other hand, I am mindful of those who say that we should proceed on the basis of existing designs; possibly by replicating or duplicating a plant which is in operation because these designs are known quantities, and this path would be the least expensive and free of regulatory roadblocks.

The details about how to implement standardization also must be seriously considered. Construction of many current plants was begun on the basis of such scant information that even industry designers refer to the plans as cartoons.

How detailed a plant design must you have to achieve the benefits of standardization? Can you proceed with a plan which is 20 percent complete, or do you need 50 percent or 90 percent of the design? Is standardization something that can be effectively mandated by regulation or legislation? Would Government-mandated standardization drive up electricity costs to unacceptable levels for the consumer?

I fully recognize that some members of the subcommittee support a speedy markup on this legislation. I can only say on a personal note, based upon my preparation for this and the previous hearing on licensing reform, that the issues pending before the subcommittee are as complex as they are important.

I look forward to continuing to work in a bipartisan way to investigate these issues and to see whether a consensus among Members on both sides of the aisle without significant opposition can be attained. Such an approach to this and other similarly complicated legislative issues before the subcommittee pose the greatest promise of sound legislative achievement.

That completes the opening statement of the Chair, and I'll recognize the ranking minority member from the State of California, Mr. Moorhead.

Mr. **Moorhead**. Thank you, Mr. Chairman. I'm pleased to be meeting today on the vital issue of nuclear powerplant standardization and licensing reform. I thank the chairman for his recognition of the importance of this issue and his commitment to address the problems plaguing the nuclear industry, as is exemplified by his decision to hold this hearing now rather than at sometime in the future.

I welcome our distinguished panel of witnesses and look forward to hearing your views on standardization and licensing reform.

As you know, in the last 10 to 15 years, the nuclear power industry has been battered by many negative forces to the point that construction of new nuclear powerplants is no longer a viable energy option in this country. One of the most important forces, if not the most important force, contributing to this result has been the NRC's regulatory process. That process has greatly extended the construction and licensing review time period, and has resulted in greatly increased costs.

Moreover, the NRC has required many changes or backfits without analyzing these backfits together to assure that there is a net improvement in the plant safety. Such a process is not in the interest of the public or the industry.

Because it is vital to preserve and enhance the nuclear option in this country, I cosponsored H.R. 1029, the Nuclear Power Plant Standardization Act of 1985. Congressmen on both sides of the aisle have recognized the need for improving the regulatory process governing nuclear powerplant construction and operation. Thus, I am pleased to say that there are almost 60 cosponsors of H.R. 1029.

H.R. 1029 contains four basic provisions. First, it provides for standardization of the subsystems of a nuclear power plant such as the nuclear portion of the plant, the balance of the plant. Second, it provides for the early review and banking of sites. Third, it provides for a combined construction permit and operating license, also known as one-step licensing. Finally, it provides for regulatory stability through the control of backfitting.

The operation of these four provisions will have several additional beneficial effects. First, the design certification and the site review process will permit early and comprehensive public participation. Much more information will be available to the public than is available today, and it will be available before construction of the plant has begun, thus avoiding the complications of the normal sunk costs.

Second, standardization and control of backfits should enhance the safe construction and operation of plants. For example, industry will be able to develop standardized programs for quality assurance, maintenance and training.

Finally, standardization will enable the NRC to focus its technical resources so that its regulatory process will be more orderly and efficient.

While I encourage the witnesses to provide us with their views on the need for licensing reform and the provisions of the three bills pending before the subcommittee, I am very interested in hearing your views on how standardization will actually work. In particular, I am interested in learning your views on how much can be standardized and how much should be standardized.

To sum up, I believe that standardization will enhance safety, focus NRC technical resources, shorten construction and licensing review time periods, and decrease costs. When these benefits are added to the other benefits of enactment of H.R. 1029, such as easier and more informed public participation, it's easy to understand why a consensus has developed in support of this legislation.

Mr. Chairman, I understand your concern about rushing to judgment, but actually if a number of us were not out there pushing and trying to get something done before it's too late, it's doubtful if anything would ever be accomplished.

So I'm very pleased with your willingness to work with us. I know that compromise is needed in legislation, and I hope that we get a bill out and get something done before the end of the 99th Congress.

Mr. **Markey**. I thank the gentleman, and I thank the gentleman for his foot in my back as well.

The gentleman from Utah, Mr. Nielson, is recognized.

Mr. **Nielson**. Thank you, Mr. Chairman. I, too, want to thank you for holding this hearing on nuclear powerplant standardization and licensing reform. One need only look at highly successful nuclear plants in programs in countries like Japan and France to appreciate the value to be derived from H.R. 1029, which I cosponsored.

If the NRC regulatory process effectively eliminated nuclear power as a future option for electricity generated by utilities, those countries have strong nuclear programs unencumbered by the regulatory morass we face in this country.

Congress should not let an out-of-date regulatory process eliminate nuclear power as an option. Not only will enactment of H.R. 1029 preserve the nuclear option, it will enhance nuclear powerplant safety, provide regulatory stability and improve the process for public input.

I look forward to hearing the views of the witnesses on standardization and licensing reform. I urge the chairman to move forward on the three bills dealing with this subject presently pending before the subcommittee, as he has done in the hydroelectric relicensing, and I commend him for his effort in that area, as well.

Thank you, Mr. Chairman.

Mr. **Markey**. Thank you, Mr. Nielson. The gentleman's time has expired. The Chair recognizes the gentleman from Ohio, Mr. Oxley.

Mr. **Oxley**. Thank you, Mr. Chairman.

I want to thank you for holding this hearing, the second in this subcommittee's consideration of the need for nuclear powerplant standardization and licensing reform legislation. I also want to thank the witnesses here with us today for providing their views on these important issues.

Everyone would benefit from the standardization of nuclear powerplants. The public is served by the enhanced safety and cheaper electricity that will result from plant standardization. For example, safety will be enhanced because safety lessons learned in one standardized plant can be uniformly applied to all other standardized plants of that type. This cannot be done with today's custom plants. Shorter construction and licensing review time periods will ultimately result in cheaper electricity for all of our citizens.

Standardization benefits the industry because it will result in regulatory stability and lower costs. The country will benefit from the preservation of the nuclear option as a means of generating electricity. H.R. 1029, a bill that I have cosponsored, the Nuclear Power Plant Standardization Act, has already garnered almost 60 cosponsors. In light of this and the significant benefits to be gained from enactment of this bill, I urge the chairman to complete our hearings on this issue and to move forward expeditiously toward markup of H.R. 1029.

Thank you, Mr. Chairman.

Mr. **Markey**. I thank the gentleman, and the time for opening statements by the subcommittee members has expired. We now turn to our panel. We only have one panel today, and I might make the point that the reason that we're having the hearing at this hour is that the full committee that we, on this subcommittee, serve on has the Superfund legislation out on the floor this afternoon and we expect to see it out sometime immediately after 1 p.m.

So our goal is to move as quickly as we can to get to the central issues that we are dealing with because we will, in fact, be losing members up here pretty quickly.

I would ask the panelists if they would summarize their opening statements in 5 minutes. That would allow us to get to questions as quickly as possible. The Chair intends on closely watching the time and strictly enforcing that 5-minute level, so please try in your minds now to summarize so that you don't run out of time with important points that have to be left by the side, although you will be given opportunities during the question and answer period to make those points.

So with that admonition, I will begin by recognizing Mr. Richard Priory, who is the vice president of Duke Power Co., design engineering, from Charlotte, NC, to begin with his opening statement for 5 minutes.

STATEMENTS OF RICHARD B. PRIORY, VICE PRESIDENT, DUKE POWER CO., ACCOMPANIED BY ALBERT V. CARR, JR., ASSISTANT GENERAL COUNSEL, DUKE POWER CO., AND BARTON Z. COWAN, PARTNER, ECKERT, SEAMANS, CHERIN & MELLOTT AND CHAIRMAN OF THE AIF LAWYERS COMMITTEE; MICHAEL E. FADEN, LEGISLATIVE COUNSEL, UNION OF CONCERNED SCIENTISTS, ACCOMPANIED BY ROBERT D. POLLARD, NUCLEAR SAFETY ENGINEER, UCS; SHELBY T. BREWER, SENIOR VICE PRESIDENT, NUCLEAR POWER SYSTEMS, COMBUSTION ENGINEERING, INC.; RICHARD DEAN, SENIOR VICE PRESIDENT REACTOR PROGRAM, GA TECHNOLOGIES; STANLEY JACOBS, VICE PRESIDENT AND ENGINEERING MANAGER, STONE & WEBSTER ENGINEERING CORP.; and LAWRENCE M. LIDSKY, PROFESSOR OF NUCLEAR ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Mr. **Priory**. Thank you, Mr. Chairman. I'd like to thank the subcommittee for the opportunity to appear before you today to present testimony in support of several concepts of regulatory reform contained in the proposed legislation. In particular, support of the concepts of nuclear plant standardization and preapproved design, early site approval, combined construction and operating licenses and stabilizing changes to the regulatory requirements.

I appear here today on behalf of the atomic industrial forum study group on the practical application of standardized nuclear powerplants in the United States. I am chairman of that organization's working group on design information requirements. My testimony here today is supported by the Edison Electric Institute and the American Nuclear Energy Council.

I'm accompanied today by Albert V. Carr, assistant general counsel, Duke Power Co. in the rear to my right, and by Barton Z. Cowan, partner, Eckert, Seamans, Cherin & Mellott, Pittsburgh, PA, and chairman of the AIF Lawyers Committee. My comments here today are based on the knowledge gained through Duke Power Co.'s experience with nuclear power.

We are currently operating six large nuclear units with a seventh scheduled to come into service next year. More significantly, however, at least for the purposes of my testimony here today before you, Duke is unique in the investor-owned utility industry in this country because we have designed, engineered and constructed all of our own nuclear plants. Therefore, I can speak from the perspective of not only a utility which operates nuclear powerplants, but also, the architect engineer and the constructor of those plants. We have also worked with three of the four nuclear steam supply system vendors in this country.

I believe the approach contained in this legislation represents a significantly different and more rational method for regulating, designing and constructing nuclear plants in this country. These legislative concepts will provide for a stabilized engineering and regulatory environment in which design engineering is essentially complete, the regulatory process is thoroughly defined, and public input is incorporated before construction of the plant begins.

I'd like to focus on two key areas which I believe must be understood for meaningful legislation to result. No. 1, the advantages of coupling standardization with licensing reform, for in my view, the two must be dealt with together. And, No. 2, the design engineering that will be completed prior to obtaining a combined construction and operating license.

Standardization in conjunction with single stage licensing and stable regulatory requirements will be a significant first step in reviving the nuclear option in this country.

First, safety will be enhanced since industry and NRC resources can be focused on optimizing a smaller number of designs, and construction of these plants can proceed with minimum disruption. Second, costs of nuclear plants will decrease because as more discipline is brought to the engineering and regulatory process, construction times can be shortened and investor confidence restored.

Third, public participation in the process will be enhanced in that the public will have more detailed design information to review at the very beginning of the process when public input is most beneficial to it.

In order to obtain a combined construction and operating license, a substantial financial commitment will be required by the applicant. I estimate this upfront commitment, based on my written testimony, to be in the range of $150 to $200 million. This is roughly

10 times the investment required to support a construction permit under the current regulations.

Let me describe briefly what that commitment will provide. We believe that to support the NRC review and approval of combined construction and operating license applications, the plant design must be sufficiently complete to provide the NRC the necessary information to make the requisite safety determination.

Methodology and procedures for testing, inspection and analysis along with, and most importantly, the acceptance criteria, will be required upfront and approved as part of the construction and operating license. The design engineering products necessary to support the application are described in detail in my written testimony. And by way of example, let me explain those two products.

The first is called the plant safety report, and it is composed of design basis criteria, analysis and design methods that will be used in the plant design; functional design and physical arrangement of the auxiliary; the balance of plant and the nuclear steam supply system; plant physical arrangement sufficient to accommodate systems and components; functional and performance specifications for all of the components and materials in the plant; acceptance and test requirements for the plant; probabilistic risk assessment methodology defined. That is what we term the plant safety report. And if you will, that is a far advanced version of the cartoon described in the chairman's opening statement.

The next list would be the construction documents that would be supplied, in detail; the design basis criteria. And let me emphasize before I go through this list, which I will do very quickly, that these are the actual construction documents, the drawings that will be used to build the plant by. Unlike the process we have used in the past in providing a safety analysis report, these would be the actual construction drawings we would provide, and we would base the $200 million investment on.

General arrangement of structures and components; process and instrumentation diagram; control logic diagrams for the plant; system functional descriptions; component and procurement specifications including acceptance and test requirements; construction and installation specifications; supporting design documentation such as bounding site data and calculations to support the prior documents; a QA program; emergency plans, security plans, ALARA and radiation protection plans, accident analysis, draft technical specifications, and a complete probabilistic risk assessment.

The large front-end investment required to support this approach will represent signficant financial risk to the industry and the investment community. We believe this risk will be balanced by the stabilizing features contained in the proposed legislation.

We urge this subcommittee to move expeditiously to report a nuclear standardization and licensing bill. Taken together, the Broyhill, NRC, and DOE bills provide a good starting point for drafting such legislation.

Planning to meet the energy needs of the 1990's requires near-term utility decisions on viable electric generating technologies. Under the current regulatory process, nuclear power is no longer a viable option for use by utilities in providing future generating capacity in this country.

This legislation offers many of the necessary ingredients to restore this generating option. It would enhance public safety, lower costs to customers, provide for early public participation, reduce investment risks and eliminate much of the waste and inefficiency present in our current process.

In summary, these legislative concepts offer the best hope for restoration of a viable nuclear option.

Thank you for the opportunity.

[The prepared statement of Mr. Priory follows:]

STATEMENT
OF
RICHARD B. PRIORY
BEFORE
SUBCOMMITTEE ON ENERGY, CONSERVATION AND POWER
HOUSE COMMITTEE ON ENERGY AND COMMERCE
U.S. HOUSE OF REPRESENTATIVES

I. Introduction

My name is Richard B. Priory. I am Vice President, Design Engineering, of Duke Power Company. I am a member of the Atomic Industrial Forum's (AIF) Study Group on the Practical Application of Standardized Nuclear Power Plants in the United States and Chairman of its Working Group on Design Information Requirements.

I am here today representing the AIF Study Group; my statement is supported by the Edison Electric Institute (EEI) and the American Nuclear Energy Council (ANEC). I appreciate your November 26, 1985, invitation to appear before this Subcommittee and would note that the questions contained in your invitation are addressed in my written statement.

Nuclear power is a significant and growing component of power supply both here in the United States and throughout the world. During calendar year 1984, more than 340 nuclear generating units provided about 13 percent of the world's electricity. Of the 220 million kilowatts of nuclear generating capacity in commercial service worldwide, the United States is by far the largest producer with about one-third of that total.

Last year, 82 nuclear plants produced nearly 13.6 percent of our nation's electrical generation. The U.S. now has 90 reactors in commercial operation. Through the first three quarters of 1985 these plants produced 288 billion kilowatt-hours, or 15.5 percent of total U.S. electrical output. Through September of this year nuclear generation increased 16.6 percent over production during the same period in 1984. The comparable increase for electricity from all sources in 1985 is 1.5 percent, according to Department of Energy figures. Nuclear's share of total electricity production is expected to rise to nearly 20 percent by 1990, when most of the 31 nuclear plants currently under construction have begun operation.

In some areas of the country, nuclear power's contribution to the electric power supply is much greater. For example, Duke Power Company, with a service area encompassing the Piedmont region of North and South Carolina, operates six large nuclear units -- with a seventh scheduled to come into service in the near future -- which produces in excess of 50 percent of our generation. At Duke, nuclear power is our lowest-cost steam-electric generation. I would also add that Commonwealth Edison, which serves the Chicago area, currently produces about 59 percent of its electric power by nuclear generation.

With the U.S. economy expanding and demand for electricity on the rise, utilities are now planning for new generating capacity that will be needed in the 1990's and beyond. But commitments for new reactors are inhibited by a licensing process developed to meet the needs of the 1950's. Both industry and government (NRC and DOE) agree that the present licensing process needs to be modified substantially. The bills which have been introduced in the Congress demonstrate this recognition.

The nuclear industry testified in 1983 in both the House and the Senate on earlier versions of the NRC and DOE licensing reform bills. In addition, Wallace B. Behnke, Vice Chairman of Commonwealth Edison Company, and Barton Z. Cowan, partner in the law firm of Eckert, Seamans, Cherin and Mellott, and Chairman of the AIF Lawyers Committee, presented testimony on licensing reform on behalf of AIF, EEI, and ANEC in mid-July of this year before the Senate Environment and Public Works Committee. While the particulars of the pending legislative proposals differ, the industry considers all of the bills to be a good starting point for consideration of improvements in the present licensing environment. On July 25, 1985, your Subcommittee held a hearing during which several senior members of our industry testified. We believe that the July 25 hearing together with the record developed here today provides sufficient information for this Subcommittee to move expeditiously to proceed to mark-up. We strongly urge you to do so now. As I just noted, utilities are now beginning to plan to add their next increment of generating capacity to meet forecasted load; without the changes we discuss here today I doubt that nuclear power will be seriously considered by any utility as a realistic option.

My statement today will concentrate on the advantages of standardization in terms of safety, costs, and early public participation. In particular, I will address the standard design certification process and amount of design information which the industry anticipates will be available in an application for a standardized plant. I believe that the industry proposal which I will discuss with you today represents a fresh approach to a matter which all of us -- the utility industry, the NRC, the public, and the Congress -- have been working on for the past several years.

II. AIF Study Group on the Practical Application of Standardized Nuclear Power Plants in the United States

An executive-level AIF Study Group on the Practical Application of Standardized Nuclear Power Plants in the United States was formed earlier this Spring to obtain the practical benefits of standardization as soon as possible and to help remove roadblocks to its effective implementation.

The Study Group has made iterative reviews of the work products of two active working groups, the Working Group on Regulatory Interactions, chaired by Mr. James Rhodes, Vice President, Virginia Power Company, and my Working Group on Design Information Requirements. The combined efforts of these groups were reflected in an "expanded outline" for a revised Policy Statement on Standardization which the industry is urging the NRC to adopt. This "expanded outline" was sent to Mr. William Dircks in a November 1, 1985, letter from Study Group Chairman John E. Ward, Vice President and General Manager of Management Analysis Company (MAC). The concepts included in the "expanded outline" were endorsed by the AIF Policy Committee on Nuclear Regulation, chaired by Mr. Wallace Behnke, Vice Chairman of Commonwealth Edison Company. The document reflected the collective judgement of the industry and demonstrated the high level of interest throughout the industry in achieving a workable standardization process.

My Working Group on Design Information Requirements was chartered to review the level of design detail required to assure the issuance of a combined Construction Permit and Operating License (COL). We subsequently recommended design information requirements and documentation requirements we felt were sufficient to satisfy NRC needs for design detail and criteria so as to enable them to complete the safety review of the facility. These levels were included in the "expanded outline" to which I previously referred and will be discussed later in this testimony.

I would like to begin my discussion by pointing out that Duke Power Company is unique in the investor-owned utility industry because we at Duke design, construct, and operate all our own power plants, including our nuclear plants. Therefore, Duke performs the role of the architect-engineer, the constructor, and the operator of a nuclear power plant. In addition, Duke also has close ties to B&W, Combustion Engineering and Westinghouse, three of the four NSSS vendors.

It is appropriate to describe at this point what we mean when we use the term "standardization" and define some of the terminology involved. In the context of the proposed legislation, "standardized design" means designs for an entire nuclear power plant, a Nuclear Steam Supply System (NSSS), Balance of Plant (BOP), and/or discrete subsystems which have been submitted to, and reviewed and approved by, the NRC. Such preapproved designs can then be relied on by a utility to form the basis -- or a part of the basis -- for an application to construct and operate a nuclear power plant. The concept by which this goal would be achieved is known as the standardized design certification process. The base document which would be used to submit the proposed standard design to the NRC for its review and approval would be the Plant Safety Report (PSR). The approved design would be known as the Standardized Design Certification (SDC).

Early in the deliberations of my Working Group, the relationships between design information requirements, standardization and single stage licensing became apparent. Design information develops progressively as commitments are made. The risk of larger investments up front is balanced by the stability obtained after receiving the SDC and the COL. Without the COL as part of the overall revised process, it is my view that we will not obtain the benefits of standardization, because it will be highly unlikely that a utility will commit to the necessary large investment. What governs here is predictability. With a single-stage licensing process the ability to plan with certainty will be realized, and the potential for change and delay which so characterizes the current process will be alleviated. Thus, in order to achieve standardization, and allow utilities again to turn to nuclear as a generating option, the COL is a practical necessity.

III. The Design Certification Process and Degree of Design Detail

The AIF Study Group supports the SDC process which can be used to facilitate obtaining a COL. This SDC process has been proposed in legislation before this Subcommittee. In this process either a utility, NSSS vendor, Turbine-Generator (TG) vendor, Architect/Engineer, or a combination of these entities, would create a standard plant and/or a major subsystem design which represents a discrete element of the facility. This proposed design would fit within the envelope of potential sites. This standard design would then be submitted to NRC, via the PSR, for review and approval. This approval would result in the SDC, and would be effective for a period of ten years with renewal options.

After an SDC has been received and a decision is made actually to build a plant, the plant owner would apply to NRC for a Construction-Operating License (COL) which would integrate site-specific information into the standard design. The opportunity for public participation regarding the adequacy of design would occur at the time the SDC is under consideration by the NRC. The opportunity for public participation concerning the adequacy of the plant site would be either in conjunction with an application for an Early Site Review, if applicable, or at the COL stage.

Under the COL concept, a single license would be issued by the NRC authorizing construction and, if the plant is built in accordance with the license, operation. Thereafter what is contemplated is a phased approval process whereby the NRC would approve construction as the plant construction progresses, based upon its review of satisfactory performance of the tests, inspections and analyses and compliance with the pre-approved acceptance criteria.

In order to support the NRC review and approval of a standard design to lead to an SDC, the plant or subsystem design must be sufficiently complete so that the applicant and the NRC have a clear definition of all sufficient safety aspects in order that construction and testing can be performed in accordance with preapproved methodology and procedures and measured against preapproved acceptance criteria. Accordingly, the following design and engineering information would be contained in the PSR:

Design Basis Criteria - The PSR will identify the criteria upon which the design of the plant will be based. Included in this section will be references to the General Design Criteria (10CFR50 Appendix A), Standard Review Plan (NUREG 0800), and the codes and standards used in design, construction and operation (ASME, IEEE, etc.). Other regulatory requirements identified will include emergency plans, QA program, materials requirements, ALARA, ECCS evaluation, fire protection, security plan and technical specifications.

Analysis and Design Methods - The PSR will identify the engineering methods, assumptions, design guides, analytical approaches and computer codes to be used in the plant design. This will include methodologies for seismic design, pipe stress analysis, and fluid flow design. Additionally, load combinations will be identified.

Functional Design and Physical Arrangement of Auxiliary, Balance of Plant and Nuclear Steam Supply Systems - The PSR will describe the major plant parameters and functional design requirements resulting from NSSS and T/G selection, and will reference appropriate preapproved vendor supplied documents. It will include listings of basic systems, structures and components, functional descriptions of buildings, major equipment layouts, and interface requirements identified by major vendors.

Plant Physical Arrangement Sufficient to Accommodate Systems and Components - The PSR will contain the general arrangement information derived from the major plant parameters and functional design requirements. Other requirements such as component removal, pull space, maintenance, and personnel access are incorporated in general arrangement information development.

Functional/Performance Specifications for Components and Materials - The PSR will contain design criteria specifications that will identify functional and performance requirements for systems and components in the balance of plant.

Acceptance/Test Requirements - The PSR will identify applicable codes, standards, regulations and acceptance criteria to be used in construction, installation, and testing.

Probabilistic Risk Assessment Methodology - The PSR will identify the methodologies, assumptions, and procedures to be used in the performance of the probabilistic risk assessment.

The SDC process is definitely not "business as usual" but represents a significantly different method of conducting the design and construction process for a nuclear power plant. In the past, the two-step licensing process led both the industry and the regulators to a design/regulatory system where only design information of a more preliminary nature was furnished on the front end leaving open the potential for significant changes on the back end. In the SDC process, much more engineering and regulatory review is done on the front end. For example, at the time of PSR submittal, the design engineering of the standard plant (described below) would be essentially complete and would be available as necessary for NRC review.

This essentially complete design engineering would encompass the following design documents and drawings:

Design Basis Criteria - This information will be addressed in General Design Criteria Specifications and Functional Design Criteria Specifications.

Plant General Arrangements of Structures and Components - Spatial orientation of walls, floors, buildings, and the equipment and systems within these structures will be identified on General Arrangement drawings.

Process and Instrumentation Diagrams - Direction of fluid flow, process information, and the components that are part of the plant systems will be identified on P&IDs.

Control Logic Diagrams - Reactor protection, engineering safety features, and BOP will be identified on Control Logic Diagrams.

System Functional Descriptions - System purpose, function, and operational requirements will be identified in System Functional Descriptions.

Component and Procurement Specifications including Acceptance Test Requirements - Equipment and material performance requirements will be identified on component and procurement specifications. Additionally, these specifications will include procurement information and the requisite codes and standards to which the materials and components shall be tested.

Construction and Installation Specifications - These specifications will identify the criteria and methods by which systems, structures and components are erected or installed in the facility. These specifications will include acceptance, inspection, and testing requirements and criteria.

Supporting Design Documentation such as bounding site data and calculations sufficient to support the above level of design detail - Requirements for systems, structures or components associated with the bounding site will be identified. Typical information necessary to establish these requirements includes meteorology, geology, hydrology, subsurface and foundations, seismology, flood studies, and auxiliary sources of nuclear service water.

QA Program - A QA program will be identified which assures conformance of the design, construction and operation of the facility to applicable regulatory standards such as 10CFR50 Appendix B, approved industry standards such as ANSI, and corresponding daughter standards or equivalent alternatives. The program includes the surveillance and inspection of design, construction, and operation of the facility.

Emergency Plans - These plans will identify actions to be followed in the event of a plant malfunction including both on-site and off-site evacuations.

Security Plan - This plan will identify provisions for the physical protection of the plant consistent with the requirements of 10CFR73. The plan will address the use of guards, watchmen, physical barriers, and visual surveillance such that sabotage, theft or diversion of nuclear material does not occur.

ALARA/Radiation Protection Plan - A program will be identified to protect employees from radiation exposure and to keep employee doses as low as reasonably achievable while the plant is being constructed, operated, and modified.

Accident Analysis - A deterministic examination of undesirable events will be performed to determine the necessary response if such events should occur. This analysis will consider occurrences classified as operational transients, faults of moderate frequency, infrequent faults, and limiting faults.

Draft Technical Specifications - These specifications will provide a description of plant operation with respect to safety limits and limiting safety system settings, limiting conditions for operation, surveillance requirements, design features, administrative controls, and definitions. The process of formulating draft technical specifications will involve obtaining standard technical specifications from the NRC and determining which specifications are applicable, which need modification, provision of applicable values of parameters and variables, figures, graphs, and other information required to complete the standard technical specifications.

Probabilistic Risk Assessment - A systematic and structured methodology will be applied to obtain quantitative estimates of the risks of various malfunctions through the use of accepted probabilistic and statistical techniques and consequence evaluation methods. Due to its comprehensive and systematic nature, PRA methodology is a powerful tool for estimating the impact of design alternatives on a plant's margin of safety.

One can see from the foregoing that a significant amount of design engineering would have been completed before submittal of the PSR to the NRC. The work required will result in a large expenditure of capital on the part of the group generating the standard plant design. In fact, I estimate these expenditures to be in the range of 150 to 200 million dollars.

This large front end commitment on the part of the entity pursuing an SDC will enhance the effectiveness of standardization. Because of the magnitude of the required commitment, there will not be a large number of different standard plant designs developed. This should enhance the quality of standard plant designs in that industry resources will be concentrated on the development of optimum designs. NRC resources will also be optimized as review is focused on a few standard plant designs, each with a consistent degree of design completion and consistent review criteria applied by NRC.

Thus, it is clear that the level of detail needed to obtain the single COL will be such as to enable specification of the inspections, tests and analysis, and acceptance criteria, which are to be an integral part of the COL. All important safety features of the plant would be addressed, and the Commission would determine the detail level needed for it to make safety findings needed for setting forth the inspections, tests, analysis and acceptance criteria. Although name plate level information would not be required (partially so as not to preclude several sources of supply), the detail required generally would be such as to support equipment procurement plus explicit procedures defining implementation of detailed design qualification, construction, and testing to be performed. It also is clear that sufficient detail would be provided up front to protect against changes due to discovery of unanticipated items relating to the safety of the plant.

In my opinion, the SDC process leading to preapproval of designs would initially be based on current reactor designs. The current generation of light-water reactors has exhibited an excellent safety and operational record and has furnished us with a large international experience base. Thus current light-water reactor technology is the prime candidate for standardization. Any improvements which are incorporated in initial submissions for an SDC generally would be market driven, based on their projected attraction to the utilities who will be constructing the plants and incorporating the preapproved designs. While advanced reactor concepts are under development by a number of parties, such developments are not sufficiently far along to serve as generation alternatives in our current planning horizons. Efforts should be made in parallel with the standardization effort to consider a framework for advanced reactors, but there is no need to await such advanced reactors to gain the benefits of standardization.

I feel that the SDC process, when combined with the COL, will help revitalize the nuclear option. It will add needed stability and discipline to the process from the perspective of both the industry and the regulator. The current two-step licensing process does not offer sufficient incentives for standardization to be implemented on a broad basis. There have been isolated exceptions to this where standardization has been pursued with some positive experiences indicating the overall benefit of standardization; however the net result has not produced what could be considered a viable nuclear option for the future.

IV. The Trade Off and the Current Licensing Reform Bills

It is our belief that the standardized design concept would, if enacted, yield significant benefits over the current licensing system. To achieve those benefits, the industry is willing to invest substantially greater resources at the initial stages of the licensing process than is presently the case. For example, as I have mentioned earlier, we envision, prior to filing an application for an SDC, a financial commitment on the order of $150-200 million for design and engineering work. That commitment would, in our view, provide substantial benefits when coupled with the proposals for a COL. The time to determine whether a plant should be built, and the design and safety parameters which it must meet, is prior to the time when construction is commenced.

The proposed approach also enhances, and makes substantially more meaningful, public participation in the NRC licensing process. As I previously indicated, opportunity for public participation is available during the SDC review to focus on the application then before the NRC. Because of the much greater level of information and detail available, any hearing held at that time will be more complete, and able to explore technical issues to much greater depth, than is now possible at the construction permit stage. At either the Early Site Review, if applicable, or the COL stage, the public could participate on site suitability, as well as environmental, matters. However, issues previously considered by the NRC in approving the SDC would be foreclosed. This process allows the public to provide input to the process at a stage where such participation is the most meaningful -- before commencement of construction is authorized.

An additional benefit is that parameters and requirements -- indeed, in some cases virtually final documents -- for matters such as quality assurance can be established prior to application for an SDC. Inspections, tests and analyses, and the acceptance criteria can therefore be considered and resolved at the SDC stage. Thereafter, the NRC can assure compliance with the license through its inspection and enforcement capabilities.

V. The Benefits

Any discussion of the SDC/COL concept is incomplete without a clear statement of the benefits to be realized therefrom. In sum, the concepts I have discussed today will increase safety, bring discipline to the licensing process, and thereby go far toward restoring to the United States the nuclear option.

The importance of attaining stability in requirements provides a powerful incentive to obtain a regulatory framework that when combined with utility discipline offers a stable process. It is thus to the advantage of the industry to provide the large investment up front in exchange for a system that allows this stability. It is also to the advantage of the utility, in terms of construction efficiency and schedules, to maintain design well ahead of construction.

The SDC/COL process will improve the process in several respects. First, in our view it will tend to improve safety, as it will allow the NRC, reactor vendors, designers, architect-engineers, and utilities to concentrate on discrete issues involved in fewer designs. The process I endorse today will eliminate the substantial demands on these technical resources now caused by design changes during the construction phase. With the SDC/COL process, safety reviews will no longer be conducted on the critical path, after a utility has commenced construction.

Standardization will substantially reduce the time for construction of a nuclear power plant by allowing design optimization, simplifying construction management, and reducing construction rework and post-construction design verification. This will in turn increase the effectiveness and efficiency of quality assurance programs. This will lower the direct costs of new plants, but most significantly it should reduce substantially the indirect costs of new plants -- primarily capitalized carrying charges, or allowance for funds used during construction -- by shortening the construction period and avoiding needless delay. Moreover, the cost of capital should be reduced by lowering the financial risk resulting from the uncertainty associated with the current nuclear regulatory environment. The reduction in licensing and construction time associated with standardization will enable utilities to plan better to meet their loads and lessen the risk of future mismatches between demand and capacity. Because a standard design would be used by several utilities, the costs of designing and building nuclear plants will be spread over a larger base. In fact, though there is a much larger commitment up front to support a standardized plant, I would like to point out that there is a distinct probability that, following NRC grant of an SDC and a COL, and construction and operation of a standardized plant, the amount of design information available for subsequent units would increase and the engineering dollar costs would decrease.

Utilities can plan additions to their systems with greater certainty, knowing that a design has already been approved by the NRC and, absent good cause, will not be changed. As noted, standardization would improve construction productivity and construction quality assurance. More efficient training of operating personnel would be possible. Improved standard designs would lead to more efficient plant maintenance and operating practices and make possible more efficient and effective NRC Inspection and Enforcement activities.

VI. Conclusion

We urge your Subcommittee to move expeditiously to report a nuclear standardization and licensing bill. Taken together, the

NRC and DOE bills provide a good starting point for drafting such a bill. The principal benefits of such legislation would be enhancement of public safety, reduction of costs to the customer, and reduction in the waste and inefficiency attending the current regulatory process. Standardized plant designs will benefit safety by concentrating the technical resources of the NRC as well as industry on a small number of designs.

Consumers would benefit from the reduced capital costs and lower financial risks associated with nuclear power plants and from the economies associated with improved on-line performance and reliability.

Thank you for this opportunity to appear before your Subcommittee.

I will be pleased to answer your questions.

Mr. **Markey**. The gentleman's time has expired. The Chair now recognizes Mr. Michael Faden, who is the legislative counsel for the Union of Concerned Scientists. He's accompanied by Mr. Robert Pollard, who is a nuclear safety engineer for the same group, who will be available to answer questions. Mr. Faden will be making the opening 5-minute statement for his organization.

Welcome, Mr. Faden.

STATEMENT OF MICHAEL E. FADEN

Mr. **Faden**. Thank you, Mr. Chairman. We're pleased to present our views to the subcommittee. We have a full statement which I would request be put in the record, and I will summarize it.

Mr. **Markey**. Without objection, that statement will be included in the record in its entirety.

Mr. **Faden**. Thank you, Mr. Chairman. We have come to this hearing as strong supporters of nuclear powerplant standardization. As you know, all three bills before you have been touted as primarily aimed at encouraging the standardization of future reactor designs. This theme reflects, in our view, a healthy, if somewhat belated, realization that many of the industry's recurrent problems stem from the "design as you go" practices that have persisted since its early years.

But more importantly, this emphasis on standardization also underlines the bill writers' need to quiet the controversy that has surrounded earlier legislative attempts that would effectively exclude the public from the nuclear regulatory process. Unfortunately, these bills go as least as far as past years' proposals, and in some respects even farther, in cutting back the rights of citizens to have a role in the licensing of reactors.

In our view, true standardization would require a complete final design that resolves all outstanding safety problems. Without these essential elements—a complete final design and the resolution of all outstanding safety issues—anything called "standardization" would be a sham.

NRC already has the regulatory authority to achieve standardization now without the passage of this or any new legislation. All the agency needs to do is to let the industry know that it will not issue a construction permit unless the applicant submits a complete final design. That one small rule change would, by itself, accomplish everything worthwhile that this legislation purportedly tries to accomplish. Only a complete design would permit meaningful NRC review, advance resolution of safety issues, and a clearly scheduled construction process.

Once NRC or Congress makes design in advance a legal requirement, economic pressures will render custom designs all but obsolete. Unfortunately, none of the bills before you will achieve standardization because none of them requires the NRC to license only plants that use the standard design, and none of them requires NRC to approve a final design before it issues a construction permit or a one-step license. In other words, none of these bills will stop the "design as you build" process. However, all three of these bills would let NRC standardize designs with unresolved safety issues, and they all would place very strict constraints on the safety-related upgrades that NRC could order once a design has been approved—too strict, in our view.

Thus, we would urge this committee to proceed very slowly and carefully before making radical changes in the nuclear licensing process, particularly if those changes are intended to bring about the goal we all share; standardization, which can be achieved without legislation.

Thank you. We'll be happy to answer your questions.

[The prepared statement of Mr. Faden follows:]

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Testimony of MICHAEL E. FADEN

LEGISLATIVE COUNSEL, UNION OF CONCERNED SCIENTISTS

Before the
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER
of the
COMMITTEE ON ENERGY AND COMMERCE
UNITED STATES HOUSE OF REPRESENTATIVES

December 10, 1985

On NUCLEAR POWERPLANT STANDARDIZATION

I thank the Subcommittee for your invitacion to appear today to discuss nuclear powerplant standardization and how it relates to the nuclear licensing "reform" bills that are pending before your Committee.

The theme of this year's nuclear licensing legislation is standardization. All three bills filed to date — the NRC bill (H.R. 1447), the DOE bill (H.R. 2488) and the Broyhill bill (H.R. 1029) -- have been touted as primarily aimed at encouraging the standardization of future reactor designs. This theme reflects a healthy (if belated) realization that many of the industry's recurrent problems stem from the "design-as-you-go" practices that have persisted since its early years.

But, more importantly, this emphasis on standardization also underlines the billwriters' need to quiet the controversy that has surrounded earlier legislative attempts to effectively exclude the public from the nuclear regulatory process. Unfortunately, these bills go at least as far as past years' proposals — in some respects, even farther — in cutting back the rights of citizens to have a role in the licensing of nearby reactors.

To the extent that their proponents focus on standardization, the effect of these bills has been grossly misrepresented. Far from simply encouraging standardized designs, these bills would fundamentally alter the balance in the Atomic Energy Act, adhered to by the Congress for three decades, in favor of public participation as a tradeoff for the preemption of state and local regulatory power in this area. As they stand, these bills only further entrench in the law the special treatment accorded the commercial nuclear industry -- the only private industry already exempt from normal tort liability as well as state and local safety regulation. This special treatment, objectionable in the abstract, is certainly not merited by the industry's record.

My testimony today will not attempt to thoroughly analyze every provision of each bill. It will not describe the nuclear licensing process and how (if at all) that process relates to nuclear power's current de facto moratorium. Both of these topics were covered in the testimony presented on behalf of UCS by our General Counsel, Ellyn Weiss, in your initial overview hearing on July 25, and were discussed at length in the testimony submitted on behalf of UCS and other organizations in 1983, when this Committee considered very similar bills. They are also treated extensively in the more recent UCS report "Safety Second: A Critical Evaluation of the NRC's First Decade".

All I will try to do today is highlight why UCS strongly supports nuclear powerplant standardization, and how the bills before you do not achieve that goal. I will not attempt to examine the closely related topics of backfitting and cost/benefit balancing, because I understand that these may be the subject of future hearings before this subcommittee.

Standardization of nuclear powerplant designs, done correctly, is a progressive concept. It can provide safety benefits as well as time and cost savings. Most other countries long ago recognized this fact and embarked on programs of standard plant designs. UCS has supported standardization since at least 1978, and we still do. But this legislation is not necessary to make it happen, and this legislation will not make it happen.

1) The licensing process does not hamper the use of standardized designs.

We must begin by pointing out that these bills -- radically "reforming" the reactor licensing process in the name of standardization -- are neither necessary nor sufficient to cure nuclear power's ills. At the outset, it is important to make one crucial observation: the root cause of the American nuclear industry's many problems is not the NRC's licensing process.

As former Commissioner Peter Bradford told a Senate subcommittee last session, "The NRC hearing process ranks very low among the issues that have brought nuclear power to its present situation. NRC hearings did not cause Three Mile Island. NRC hearings did not bring about the cancellation and default at the WPPSS units. NRC hearings had nothing to do with the quality assurance breakdowns at Diablo Canyon and Zimmer. NRC hearings are not causing the Midland containment to sink. NRC hearings are not even at the bottom of the cost overruns at Shoreham and Seabrook."

Most of these misfortunes stemmed from the industry's failure to finish designing its reactors before it starts building them. Its historic "design-as-you-go" approach has been responsible for many -- if not the great majority -- of the cost overruns and safety lapses that have made headlines in recent years. By hampering advance planning, making quality assurance immeasurably more difficult, and exacerbating the need for expensive change orders and reworks, this basic industry practice has done more to raise the costs and extend the duration of nuclear powerplant construction than an army of intervenors could ever do.

The legislation before you is unnecessary because NRC already has all the legal authority it needs to license standardized plant designs -- a point the agency admitted in its 1983 Congressional testimony. Under NRC's rules (10 C.F.R. Part 50, App. Q pars. 5, 7), any standard design it approves can be referenced in a license application, and no other party can subsequently challenge the design's validity. Thus, once the standard design has received NRC approval, it is difficult for the NRC Staff to order design changes and virtually impossible for citizen intervenors to raise design issues in any later license proceeding.

In fact, NRC has all but approved two standard designs submitted by General Electric and Combustion Engineering. Westinghouse is developing an advanced pressurized water reactor design, which it expects to submit for NRC approval. It is hardly the case that NRC has erected barriers to standardization; instead, the industry, for reasons of its own, has until recently insisted on building custom-designed plants.

2) True standardization requires a complete, final design that resolves al outstanding safety problems.

What does "standardization" really mean? In our view, it means th approval by NRC of a complete, final plant design that can be used to buil more than one plant, at more than one site. A necessary part of thi approval, in our view, must be the resolution of all safety issues that aris in connection with the design. Without these essential elements -- complete, final design, and the resolution of all outstanding safety issues - anything called "standardization" would be a sham.

NRC already has the regulatory authority to achieve standardizati now, without the passage of this or any new legislation. All the agency nee to do is let the industry know that it will not issue a construction perm unless the applicant submits a complete, final design. That one small rul change would, by itself, accomplish everything worthwhile that th legislation is purportedly trying to accomplish.

The key element of standardization is simply directing the applica to submit a complete, final design before construction begins. Only complete design permits meaningful NRC review, advance resolution of saf issues, and a clearly-scheduled construction process. Once NRC (or Congre makes design-in-advance a legal requirement, economic pressures will ren custom designs all but obsolete.

Let me explain further. We believe that, at a minimum, any design that is to be standardized must encompass the nuclear steam supply system (NSSS) including all engineered safety features; the containment building; and essential auxiliary supporting systems, such as the cooling water for the emergency core cooling system and the electrical power system for the engineered safety features. We would not let NRC approve more limited designs for standardization purposes.

We come to this conclusion because past review of reference designs that were narrower in scope presented difficult problems in defining the necessary design characteristics of the excluded portions of the plants. These "interface problems" became essentially unresolvable because of the complex interactions between the standard portion of the plant and the remainder.

We also do not see any advantage to the standardization of only plant subsystems. Because of the numerous functional interdependencies between plant systems, NRC would have to review each combination de novo. Thus any benefits of standardization would ultimately be lost.

In our view, a complete, final design is one that contains the same level of detail as is now required to support the issuance of an operating license. We are aware that certain elements within the nuclear industry -- especially prominent architect-engineering firms -- have said that only minimal "design concepts", containing as little as 20% of the finished engineering drawings, may be needed for a "standardized" design. We unequivocally reject that view, and expect NRC to do so as well.

If genuine design standardization becomes the rule, it will, of course, bring numerous cost and time savings -- in construction even more than licensing -- to the industry. That is obviously why they are (at least in public) advocating it so strongly. But it is important for the Congress not to lose sight of the primary reason that standardization should be required, rather than merely encouraged.

As long ago as 1973, in its study entitled "Methods for Achieving Standardization of Nuclear Power Plants", the NRC Staff observed that "The most important advantage (of standardization) is the enhancement of reactor safety due to the concentration of staff effort on the in-depth review of standardized systems and on the resolution of generic safety-related issues that arise in the review, as well as in later construction and operation of the plant."

In other words, the public should support standardization primarily because it will lead to safer reactors, as well as cheaper and more reliable ones. In that light, any standardization policy that does not demand the resolution of all outstanding safety issues that arise in a given design is simply not in the public interest.

At this point UCS does not have fixed views on what kind of reactor the industry should attempt to standardize. While we see no inherent reason to abandon the light water reactor, we would not recommend the standardization of existing designs without distinctly improved margins of safety and reliability. But we would also encourage the industry to examine other reactor concepts if they appear to be economically feasible -- as long as this can be done other than at taxpayers' expense. (In our view, there has never been any question that engineers could design a virtually meltdown-proof reactor; the question has always been whether they could design one that is economically competitive.) At any rate, we would commend to this Committee the recent testimony of Commissioner Asselstine before a Science and Technology Subcommittee for a thoughtful, farsighted analysis of how NRC and the industry should approach the design and regulation of future generations of reactors.

With this background, let us examine the bills before you to see what sort of "standardization" (if any) they will achieve.

3) These bills do not rule out "design-as-you-build" plants.

None of these three bills requires NRC to license only plants that use a standard design. Nor does any bill require NRC to receive and approve a final plant design before it issues a construction permit or a "1-step" license. In other words, none of these bills guarantees standardization or stops the "design-as-you-go" process.

The DOE and Broyhill bills do not even define what is meant by a standardized design. The NRC bill (sec. 202) defines a "standardized design" as "a design which the Commission determines is sufficiently detailed and complete to support licensing" of a commercial reactor "or approval of a major portion of such a facility...and which is usable for a multiple number of units and/or at a multiple number of sites without reopening or repeating the review." Since NRC has previously used its discretion to allow reactors to begin construction after reviewing only a "conceptual" design outline, this definition gives little confidence that the Commission will ever insist on a substantially complete, final design.

In fact, industry leaders appear to believe that NRC should accept for a construction and operating ("1-step") license roughly the same level of design detail -- in the future called "design criteria" -- that it now requires for a construction permit. Under this process, the detailed engineering drawings would be developed in a later "design implementation stage". (As we alluded to earlier, the trade press has quoted technical staff of a prominent architect-engineer as suggesting that "at least" 20% of the plant's engineering would have to be completed before NRC issues a 1-step license -- which would be no improvement at all over past practices.) Thus it is clear that none of these bills would prohibit NRC from approving "designs" and licensing plants on the basis of 20-25% of the final plant design -- an indefensible compromise in any legislation that purports to encourage design standardization.

4) These bills would let NRC standardize designs with unresolved safety issues.

The drafters of this legislation fail to recognize that standardization only improves the safety of plants if the design that is standardized has resolved the safety problems that have persisted in the custom-designed plants. None of these bills directs the NRC to reject a design unless all outstanding safety issues have been resolved. This omission would allow the NRC to institutionalize, in a standard design, the avoidance of the final resolution of generic safety issues that has characterized its approval of custom designs for two decades.

5) The bills insulate standard designs, once approved, from future upgrades.

Although all three bills add little to NRC's authority to approve standard designs, they do restrict the agency's authority in certain dangerous ways. In brief, the bill drafters' quest for regulatory "stability" has led them to effectively choke off NRC's authority to order most, if not all, safety-related upgrades. Such upgrades would, of course, already be minimized because, if a complete, final design has been submitted in advance of construction, it would have been fully reviewed and approved by NRC.

All three bills would make it very difficult to raise any serious design issue once NRC has approved a standard design, either in a subsequent plant license proceeding or in an amendment to the design approval itself, regardless of whether the particular issue was litigated in the original design proceeding. The proponent of reopening must show that any proposed design modification is "required" to protect the public health and safety -- a tall order, when even the NRC needs a great deal of research to fully analyze many emerging safety issues.

By also demanding that any design modification must "substantially enhance" the public health and safety by "improving overall safety" of plant operations, the NRC and Broyhill bills redirect the agency's focus from the reliability of any individual plant safety system to the more amorphous calculations of "overall" plant safety that are easily manipulated in a probabilistic risk analysis.

The DOE and Broyhill bills would apparently make a design approval "conclusive" for 10 years, no matter what information is later discovered. It is extremely ill-advised to statutorily prohibit the prompt correction of design mistakes. Should NRC have licensed clones of TMI-2 immediately after the accident? This language would on its face ordain just such a result, by precluding the Commission from ordering changes in a design it had previously approved.

The NRC bill makes the design approval effective for 10 years, with a single 10-year renewal granted almost automatically. The bill shifts the burden of proof to the public to show that the design does not meet current safety standards. Under current law, the burden would remain with the approval-holder to show that the design still meets those standards -- a potentially difficult burden, given the many new safety issues that arise during any 10-year period of reactor development.

The DOE and Broyhill bills go even further, allowing an infinite number of 10-year renewals for design approvals with a similar shift of the burden of proof. None of the bills contains a "due diligence" requirement to assure that a design approval-holder is making its best efforts to upgrade the design. The net result is to encourage NRC to "grandfather in" obsolete designs for decades.

(All three bills also subsidize the nuclear industry by directing NRC to defer payment of the application fee for design approvals until the design is actually used, or until the end of the 10-year approval period. This amounts to an interest-free loan of millions of dollars to companies like Westinghouse and General Electric -- hardly the most needy recipients of scarce federal credit.)

Section 193f of the DOE and Broyhill bills would effectively nullify all restrictions in an approved design or operating license. This remarkable provision expands a clause in NRC's rules to allow licensees, at their own discretion and without notice to NRC, to deviate from "any aspect of" the approved design unless the licensee determines that the deviation involves a change in technical specifications or an unreviewed safety question. We can confidently predict that licensees will not be overly strict in interpreting these standards, since, as Saint Benedict observed 5 centuries ago, it is far easier to beg forgiveness than to ask permission.

Finally, we must point out that, while the scope of the NRC bill is generally restricted to light-water reactors, the DOE and Broyhill bills would also apply to designs for breeder reactors and reprocessing plants -- two relatively untested and possibly even more dangerous types of nuclear facilities. The bills' procedural shortcuts and backfitting constraints are entirely inappropriate when not one commercial breeder reactor or reprocessing plant is under serious consideration, much less operating in this country.

Mr. **Markey**. Thank you very, very much. Our next witness is Dr. Shelby Brewer, who is senior vice president for Nuclear Power Systems, Combustion Engineering, from Windsor, CT. Welcome, Dr. Brewer.

STATEMENT OF SHELBY T. BREWER

Mr. **Brewer**. Thank you, Mr. Chairman. I have a prepared statement which I would like to have offered for the record.

Mr. **Markey**. Without objection, that will be included in the record.

Mr. **Brewer**. While my written testimony, Mr. Chairman, covers the need for licensing reform legislation and discusses the various bills before Congress at this time, because of the limited time available in this hearing, I would like to rush to the heart of the issue highlighted in your letter of November 26, and present my views on how standardization can be implemented, how it should be implemented based on Combustion Engineering's extensive experience in designing and building and bringing into operation its own standardized system.

Now, the issue which apparently has the legislation stalled at this time is simply this: in exchange for reducing the custom, ad hoc mode of regulation, what degree of standardization is industry willing to achieve? What is the industry quid, in other words, in exchange for a more stable regulatory process afforded by the one-step licensing feature?

This question breaks logically down into two subquestions, which you highlighted in your opening statement, Mr. Chairman. First, what degree of design detail must be available to the NRC upfront? At one end of the spectrum, shall it be only a conceptual cartoon, or at the other end of the spectrum, shall it contain complete blueprints of the plant including manufacturing detailed drawings of the major components. Second, what is the scope of standardization? Should it embrace the entire plant or modularized subsystems?

The two questions are coupled, but let me take the first question in isolation. I am not persuaded by positions which would plead for regulatory stability on the one hand, but demur on providing design detail upfront on the other hand.

The argument is made, for example, that developing a high level of design detail would be a very large new investment for the industry with no assurance that the design would be approved. I reject that argument. In the case of Combustion Engineering and General Electric, that investment has already been made. In Combustion Engineering's case, the design is available now, with all of the post-TMI changes, and a standard plant in fact is now operating at Palo Verde; Palo Verde No. 1. And incidentally, Palo Verde No. 2 was licensed for an operating license last night. So there are two standard plants which have been brought to an operating license position already. Palo Verde No. 3, the third in the C-E series of standard plants, will come on line in 1987.

We have made that investment, over $100 million, in our plant. As I said, there are two more plants in the pipeline—two or more plants in the pipeline, and we will offer that plant, that design, in the future as the market develops and until cumulative design approvals warrant an application for a new standard design approval. So it is not as if we at Combustion Engineering are treading into an unknown region requiring protection of a future investment. For these reasons, I reject the notion that less, not more, safety related detail should be available up front. Combustion Engineering has accomplished standardization of the nuclear system and we will provide to the NRC in any future licensing action, the complete detailed design down to the nuts and bolts, and all of the supporting engineering analysis.

The degree of detail question, Mr. Chairman, cannot be answered independently of the second question: the scope of standardization. Degree of detail to be submitted to NRC upfront for a given plant subsystem depends on the relevance of that subsystem to the safety performance of the plant.

The nuclear portion of the plant; that is, the nuclear steam supply system, is the heart of the plant, and that's where most of the safety considerations are focused. The nuclear steam supply system consists of the equipment and engineering of the energy source, the core, the fuel, the primary heat transport system plus associated controls and protective systems. This content is traditionally the scope of NSSS companies such as Combustion Engineering.

For the NSSS, Mr. Chairman, I would argue that complete design detail and supporting engineering data and analysis should be provided to NRC upfront if it will prevent secondguessing later in a design-as-you-go process with NRC.

For the balance of plant, however, which contains much equipment that is not safety related, the design detail available upfront could be considerably less.

In any event, the process we envision for standardized plants would allow for certification and banking of the nuclear portion, the balance of plant and the site. The NRC would not issue a combined construction and operating license until a whole plant had been presented and approved in its entirety. Use of a certified or preapproved system or site would simply eliminate the need for agency re-review.

Thank you very much, Mr. Chairman.

[The prepared statement of Mr. Brewer follows:]

STATEMENT OF SHELBY T. BREWER

SENIOR VICE PRESIDENT
COMBUSTION ENGINEERING, INC.

TO THE
SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER
OF THE
COMMITTEE ON ENERGY AND COMMERCE
UNITED STATES HOUSE OF REPRESENTATIVES
DECEMBER 10, 1985

Thank you, Mr. Chairman, for the opportunity to provide testimony to this Committee as it considers legislation on nuclear licensing and regulatory reform.

I am Shelby T. Brewer, Senior Vice President, Combustion Engineering, Inc. Combustion Engineering is a major supplier of electrical generating systems -- both fossil-fired and nuclear -- oil and gas refinery systems, other major chemical processing systems, and industrial process control systems. We serve markets here in the U.S. and around the world. I am Chairman of the Board and a Director of American Pole, and a Director of Electro-Mechanics, CE-Delas-Weir and Power Systems Energy Services, Inc.

My principal responsibility is the management of the Nuclear Power Systems Division of Combustion Engineering. Combustion Engineering designs and manufactures complete nuclear reactor systems, including nuclear fuel. We have manufactured most of the major nuclear components that are currently in use in the United States - including components used by our competitors. We also provide continuing engineering services to owners of our plants as well as to the owners of equipment supplied by our competitors.

I would like to take this opportunity to present my views on the need for licensing reform legislation and the various proposed bills before Congress. At the end of my presentation, I will provide an extended discussion on how standardization can be implemented by the NRC and the nuclear industry, based upon Combustion Engineering's experience designing and building its own standard design.

The Nuclear Recession

As you know, Mr. Chairman, civilian nuclear power was developed and demonstrated in the 1950s and early 1960s, following President Eisenhower's initiatives in 1953-54. The technology was deployed rapidly and aggressively in the late 1960s and early 1970s. Since the mid-1970s, however, commercial nuclear power has been in a "recession". Over one hundred plants have been cancelled or deferred and the order rate for new capacity has dropped from over twenty units per year to zero.

To place the need for licensing and regulatory reform in context, I believe that it is important to enumerate the complex and inter-related factors which have led to this "nuclear recession":

- A downturn in the growth of electrical demand in the 1970s, which left utilities with excess capacity under construction.

- A prolonged period of high inflation and high interest rates during the 1970's which, together with extended licensing and construction schedules, resulted in quantum escalation of nuclear plant capital costs.

- Utility difficulties in forming capital for new or ongoing construction programs, resulting from unfavorable rate constraints and the retrenchment of the financial community.
- An antiquated, chaotic and unpredictable nuclear licensing and regulating system --- a system which added construction scope and prolonged schedules in a period of high inflation and high cost of money.
- Erosion of public and political support.
- Utility management difficulties in absorbing a new, largely unstandardized, technology in the face of this bewildering array of institutional maladies.

My point, Mr. Chairman, is that, although the technology has performed well, the institutional structure -- the labyrinth of entities which supply, operate, finance and regulate the enterprise -- has not. And the regulatory apparatus, while it is not the only malefactor, is certainly a dominant one.

The Need to Standardize the Product and the Process

We are faced with a situation where a perfectly sensible and necessary energy option may be denied further deployment in the United States. While there is time, we must take steps to standardize the product and the process, and to reform and improve the practices of the regulated and the regulators.

The nuclear industry is moving on its own to standardize the product. For example, Arizona Public Service Co.'s Palo Verde Unit #1 has recently been licensed to operate by the Nuclear Regulatory Commission after it referenced a pre-approved Final Design Approval held by Combustion Engineering for its System 80^{TM} standard design - the first and only time this procedure has been used in the United States. Prior to unanimously voting the 100% Power License for Palo Verde, the NRC Commissioners praised the project, calling Palo Verde "the plant of the future" and representing "the wisdom of the standardization approach."

Combustion Engineering's System 80 is the only reference standard design which has not only been approved under the existing NRC regulations but has actually been constructed and operated. Combustion Engineering has thus achieved standardization! As a result, we are currently able to offer an NRC-approved standardized design, which has been proof-tested and operated at Palo Verde.

We would offer this with our usual abundant warranties but without all of the custom-design-as-you-go engineering that was typical in the 1970's. Combustion Engineering has a standardized product which has, in fact, been developed and had its design details approved by the NRC.

Another example of the industry moving on its own to standardize the product is the Advanced Light Water Reactor Program being conducted by the Electric Power Research Institute. The program's objective is to prepare standard specifications for the design of the next generation of nuclear reactors in the United States. Combustion Engineering is pleased to be a leading participant in that program.

As I have said, industry is moving on its own to standardize the product, but standardization of the licensing process calls for action by Congress. Although the Nuclear Regulatory Commission could implement most, if not all, of the proposed reforms on its own, the U.S. utilities and nuclear industry believe that such changes must have the support of Congress and the strength of law before they can again consider investing billions of dollars in the nuclear option.

The current nuclear regulatory process and apparatus was established over thirty years ago to meet the requirements of a time when the technology was developmental and when applications for permits and licenses were few, if any. The 1954 Atomic Energy Act has been revised from time to time, but its basic structure with regard to licensing is antiquated and is not appropriate for a mature energy industry.

Reform Will Enhance Public Health and Safety Record

Licensing and regulatory reform is necessary for the continued viability of a nuclear economy in the United States and it is necessary to sustain and enhance the excellent public health and safety record of this technology. These are not mutually exclusive goals.

There is a popular notion that the various forms of legislation being proposed will somehow yield profit for the nuclear sector at the expense of public health and safety -- that streamlining the regulatory process will short-change public health and safety considerations and, further, that it will frustrate public participation in the regulatory process. Nothing could be further from the truth.

In reality, the current legislative proposals will make public participation more meaningful and effective by encouraging public input early in the licensing process, before the momentum of a massive sunk investment clashes with public concerns voiced late in the process. Moreover, under the Standardization and Construction and Operating License (COL) provisions, there will be essentially complete designs to provide the basis for public review, as opposed to the haphazard piecemeal "design-as-you-go" process in which construction permits are sought with little of the design details complete (and that subject to change). Making societal decisions up front, under the standardization, siting, and COL provisions of the proposed legislation, serves all parties in the regulatory process -- the public, the ratepayers, the utilities, and the financial community.

At the heart of our current problem is the heterogeneous and pluralistic way we have deployed nuclear power in this country. We are now approaching 100 operating nuclear units in the U.S. and by and large they are all unique: custom designed, custom manufactured, custom constructed -- and custom regulated. The standardization provisions of proposed legislation serves both the needs of the business community for more regulatory stability and the maintenance of our excellent record in public health and safety. Public health and safety goals are better served by focusing the regulator's technical resources on fewer standardized plants or systems, rather than a plethora of individualized designs.

The public health and safety goal is served also by requiring a more disciplined and systematic process for imposing retrofits in operating plants or plants under construction. A major concern with the current process is that a retrofit requirement in a subsystem may actually adversely impact the safety of the plant as a whole, and that the sheer accumulation of undisciplined retrofit requirements may lead to less, not more, safety.

Whatever one's persuasion is as to the efficacy of nuclear power, there seems to be a vast and growing broad based consensus that licensing reform is necessary to maintain and enhance the excellent public health and safety record of this technology. In the past half-decade, several panels have been convened to consider the nuclear licensing issue. These panels were not known for their knee-jerk, pro-nuclear positions on the issue. For example, President Carter appointed the Kemeny Commission after the Three Mile Island accident. A principal finding of the Kemeny Commission was:

> "To prevent nuclear accidents as serious as Three Mile Island, fundamental changes will be necessary in the organization, procedures and practices -- and above all -- in the attitudes of the Nuclear Regulatory Commission ... "

Similar or even more trenchant conclusions came out of the Babbit Committee, the Rogovin Study, and a host of other inquiries.

Even the regulators have concluded that the escalation of undisciplined regulation may lead to less, not more, public health and safety:

> "It is the finding, notwithstanding the competence and good intentions of the staff, that the pace and nature of regulatory actions have created a potential safety problem of unknown dimensions."*

In the past year, the Commissioners themselves have underscored this sentiment in Congressional hearings.

The nuclear regulatory process is unstable, unpredictable, and out of control. This condition is not only debilitating to the business and technical sectors -- it may be harmful as well to sustaining the excellent record of public health and safety that this technology has achieved. Reform is needed. Reform is needed to enhance the excellent safety record as well as to reverse the retrenchment of the business community. Reform is a win-win, not a win-lose proposition.

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* Nuclear Regulatory Commission Report, 1980

Is Reform Needed Now?

But is reform needed now? Is it an urgent problem? With a dearth of new applications, can't this issue wait?

Clearly we have a lull in licensing activity. The NRC case load is down. I believe, Mr. Chairman, that Congress should use this slack period to constructively reform and standardize the licensing process, free from the heat and pressure that a full NRC docket would bring. We have some time to perfect the process and this time should be used constructively.

Moreover, without nuclear licensing and regulatory reform legislation, it is unlikely that the utilities and the financial community will step up again and place major investments at risk. Absent reform legislation, nuclear power will not be available as an option for new generating capacity.

The present capacity buys us time to modernize the nuclear regulatory system, free from pressures and acrimonies. There is some time for each of the

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parties -- the utilities, their suppliers, the financial community, the public, the regulators and the Congress -- to take stock, to define their respective responsibilities and their respective requirements, and to design a regulatory process which serves all of this nation's interests.

The Key Features of Legislative Reform

A great deal of study and debate has gone into the subject of nuclear licensing and regulatory reform. Several legislative proposals, in fact, were made in the early 1970s by then-Commissioner James Ramey. Another Bill was prepared in 1978 by the Carter Administration. The Reagan Administration offered legislation in 1983, and it was my privilege, as Assistant Secretary of Energy, to represent that legislation before Congress. The Nuclear Regulatory Commission also proposed legislation in 1983. Hearings were conducted in both chambers of Congress in 1983. Finally in 1984, Congressman James Broyhill, et. al., submitted compromise legislation before the House.

Early this year Congressmen James Broyhill and Ralph Hall re-submitted Congressman Broyhill's 1984 proposal, and this was followed by a similar proposal by the Department of Energy in May. A Nuclear Regulatory Commission proposal was submitted in March. Each of the 1985 proposals deal in slightly different ways with the filigree of four basic elements:

- Plant or subsystem standardization;
- Pre-approval of nuclear sites;
- Single step licensing -- the option of a combined Construction and Operating License (COL); and
- A coherent retrofit process.

I would like to take this opportunity to offer my views on each of the above features as they are addressed by the current legislative proposals from the Department of Energy and the Nuclear Regulatory Commission. First, however, I would like to comment upon the similarity of the three proposals. The current proposal from the Department of Energy is a "stripped down, no frills" version of the 1983 Reagan Administration Bill. It contains the minimum features necessary to streamline the nuclear licensing process. The most notable feature of the 1983 proposal that is not included in the 1985 model is the hybrid hearing process -- which was the source of considerable controversy during the 1983 hearings.

The Broyhill-Hall bill is very similar to the 1985 DOE bill. In general, I would consider the two bills to be equivalent, and I find it heartening that the Broyhill-Hall bill has received such strong bipartisan support from other members of the House. It commands our support, as well.

The current proposal from the Nuclear Regulatory Commission has been considerably reworked from its 1983 version and, in my opinion, vastly improved.

There is now enough similarity between the three proposals that I am confident that Congress can quickly and efficiently move the Bills through markup and develop a single Bill that can be enacted during this session.

My views on the key features of these proposals are as follows:

Standardization:

All three proposals direct the Commission to establish procedures to pre-approve standard designs for nuclear plants. They also provide the opportunity for public involvement in the licensing of standard designs. Public participation, as early in the licensing process as possible, benefits everyone -- the public, the Nuclear Regulatory Commission and the nuclear industry. To assure stability (by assuring finality), however, final Commission decisions must not be reopened by insignificant and/or unfounded safety concerns during the construction or operation of a nuclear plant. All three legislative proposals provide a reasonable system for addressing any new safety issues.

There are a number of provisions in the proposals from DOE and Broyhill-Hall, however, that provide a necessary degree of flexibility. For example, they direct the Commission to allow pre-approval of major subsystems in a plant design. This is an important flexibility that should be provided if we are to balance the advantages of standardization with those that derive from competition within a free market. And this flexibility need not auger a custom, one-of-a-kind future.

Pre-Approval of Sites:

All three proposals provide for the early approval of a nuclear plant site, in a process similar to pre-approval of standardized designs. Again, they provide for early public participation, with a system for resolving new safety issues that may arise later in the licensing process.

Single-Step Licensing:

All three proposals provide for issuance of a single license to construct and operate a nuclear plant. There is a significant difference between the benefits of a standardized design and those that flow from a pre-approved standardized design. A pre-approved design can support a single license and a single license (COL) assures that all significant safety issues are resolved prior to beginning construction. (That also means that they are resolved prior to the major financial investments.)

Regulatory emphasis during construction would be placed on assuring that the plant is erected as per the licensed design, as opposed to participating in a design-and-regulate-as-you-go relationship with an applicant. Once more, the proposals provide for early - and more meaningful - public participation.

Retrofits:

The Administration's proposal provides a system by which the Commission may evaluate retrofits to licenses already issued by the Commission. The Broyhill-Hall proposal provides for a similar system. Please be assured that I am not calling for the removal of the ability of the Nuclear Regulatory Commission to require needed safety improvements. We in the industry have, rather, been requesting a rational and disciplined system for evaluating proposed changes to determine which should be required and which not.

Top NRC officials themselves have recognized the problem of cascading retrofits -- and responded, after years of debate, with a new Backfit Rule (effective November, 1985). Although this rule appears to have the features sufficient to address the retrofit problem, so did the previously existent regulation. Unfortunately, that regulation was simply ignored by the NRC staff, according to a report by the NRC's own Regulatory Reform Task Force (chaired by James Tourtellotte). To ensure the new regulation does not ultimately fall into similiar disuse, it is necessary that Congress provide statutory requirements which the Commission cannot ignore.

I must emphasize that the retrofit feature is vital to the success of the entire package. An approval on a standard design would be meaningless if it were continously retrofitted without restrictions. I believe that control of retrofitting is, in fact, the litmus test for standardization and I consider the lack of a retrofit provision in the Nuclear Regulatory Commission proposal to be a major flaw in assuring stability to the licensing process.

Hybrid Hearings:

Although the 1983 Reagan Administration bill sought to simplify the hearing process through the use of hybrid hearings, none of the current proposals seek such a change. Instead, they focus on providing early public participation and assuring that tests of reasonableness are considered before new issues are admitted to hearings late in the process. Assuming that these features remain in the legislation and achieve the desired goals, then the format of the hearing process becomes less important.

Pre-Approved Standardization: How It Can Be Implemented

I would like to take this opportunity to clear up some of the confusion which abounds as to how standardization can be effectively implemented by the nuclear industry and the NRC. As I stated earlier, Combustion Engineering's System 80 is the only reference standard design which has not only been approved under the existing NRC regulations but has actually been constructed, licensed and operated at Palo Verde. At Combustion Engineering, therefore, a pre-approved standardized design is a reality, not an abstraction.

Based on C-E's over ten years of experience with standardization, I would like to provide you with our insight into several of the questions which have been expressed with regard to implemenation of a pre-approved standardization program. To paraphrase the questions in your letter of November 26, 1985;

- o What level of detailed design information is necessary before approval of a standard design can be granted?
- o Should changes in technology be required before approving standard designs?
- o Should the NRC be authorized to approve "major portions" of a standardized plant design?

Let me address each of these questions in turn.

Level of Detail:

Most of the confusion over the level of standardization that can be achieved stems from varying perceptions in how different organizations view a nuclear plant design. Shortly after moving to

Connecticut, I remember being confronted with a map entitled "A New Englander's View of the United States." The map showed a distorted view of the U.S., in which the six New England states were larger than the other forty four states combined. In a similar fashion, the NRC views nuclear plants with a skewed -- but not unreasonable -- view that is biased toward the safety systems in the plants. The reactor itself is viewed as bigger than life, while other components, with little or no safety significance, are hardly noticed. Such a lopsided view by the NRC is indeed proper, since the NRC's function is to assure that the health and safety of the public is protected. The utility, on the other hand, must view the plant design from a more balanced perspective that includes safety and financial considerations. The purpose of this analogy is to make the point that, in order to assure the protection of the public, it is desirable to provide a high level of standardization to the safety related systems in a nuclear plant, while a lower level of standardizacion is without consequence for the remainder of the plant. The utility should, therefore, be allowed the flexibility to change and modify the components that are without immediate consequence to plant and public safety.

Let me give an example to clarify this point. If two nuclear plants were built using the same standard design, the NRC should expect the reactor vessels in both plants to look identical because the reactor vessel is so important to plant safety. At the opposite extreme, however, the telephone system may look considerably different between the two plants because the telephone system has very little safety significance. Both telephone systems would fulfill an identical need but need not do so with identical hardware. It is certainly possible to standardize down to the level of detail of a telephone system -- but especially in the extreme case I have cited -- it is obviously not necessary or cost-effective to do so.

During the NRC's review of C-E's System 80 standard design, we found that we could provide all of the necessary safety information and even well over ninety percent of the final information traditionally supplied by custom (non-standard) applicants for an Operating License. This was achieved for example, utilizing design information available from our Palo Verde, WNP, etc., efforts and by conservatively enveloping the characteristics of potential plant sites in the U.S. The small remaining portion (less than 10%) consisted of information that the NRC did not really need, but had previously been supplied, simply because it was readily available in custom (non-standard) Operating License reviews. That information fell into three general categories: brand names and model numbers of equipment to be purchased from sub-vendors; "as-built" data, and the results of site-specific calculations.

Let me explain how we successfully resolved these issues by using the first category as an example. In our application for a Final Design Approval, the NRC asked for tables of the brand names and model numbers of instruments, valves, and pumps. The essence of the information they required was: the instrument's function; the quality control requirements applied to it; the environment in which it is required to operate; the source of power for the instrument; and so on. In the industry, we refer to this as the methods and procedures that will be used to design and purchase the equipment and the acceptance criteria that it must meet. This is the type of information that we successfully provided to the NRC for our System 80 design.

As it turns out this approach actually benefited the safety review process because the NRC received and focused on more detailed safety-related information than they had by simply looking at brand names. (The NRC can, of course, still obtain brand name information during construction of the plant by auditing the utility's files.)

An additional advantage of defining and documenting the methods, procedures and acceptance criteria is that the NRC's audits of plant construction could be better focused and thus be significantly more valuable. The inspectors will now know - in advance - what is important, what they are checking, and how to check it.

Changes in Technology:

The nuclear plants that are coming on-line today are based on a technology that has been developed and refined over the last 30+ years. The American public would not be well served by abandoning this vast wealth of design information and operating experience (both good and bad) available upon which to build.

I suggest, rather, that two independent paths be provided to the future. The first is an "improved" nuclear plant design based on improvements to the best that we have available today. These "improved" designs -- including the "lessons learned" from Three-Mile Island and technical resolution to all applicable NRC Unresolved Safety Issues -- can provide the basis for a viable standardized nuclear option in the near and mid-term. For the mid-to-long term, more "advanced" nuclear plant concepts can emerge to take their place as standardized nuclear power plants. The paths I have outined are clearly not mutually exclusive and both will benefit from the proposed bills.

In your consideration of these bills, however, I urge you not to let "the best be the enemy of the good" but rather let the criteria remain that nuclear power plants may be deployed if they provide reasonable assurance: (1) that the activities authorized can be conducted without endangering the health and safety of the public, and (2) the issuance of the license will not be inimical to the common defense and security or to the health and safety of the public.

Major System Approval:

Each of the proposed bills before the Committee would authorize issuance of a COL only when all of the necessary information (nuclear plus balance-of-plant plus site) has been received, reviewed and approved by the NRC. No license will issue if any information necessary to complete a safety review is unavailable in any of these areas. What seems to be in question, therefore, is the size and shape of the packages in which the NRC gathers and pre-approves that information.

In order to benefit, to the maximum extent possible, from favorable foreign experience with standardization -- and yet retain the advantages and improvements that come with a competitive economy -- some flexibility in the non-safety related portions of the design should be maintained. Since the nuclear portion of the plant generates and contains the radioactive material, it rightfully commands the most regulatory attention. As a result, the nuclear scope [see Figure (1)] needs to be the most standardized. Its pre-approval is, therefore, key to closing out each significant safety issue.

As can be seen in Figure (2) the process we envision for standardized plants would allow for "certification" and "banking" of nuclear and balance-of-plant designs, as well as sites.

The NRC would not issue a combined Construction/ Operating License (COL), of course, until a whole plant had been presented for its approval. Use of a certified (or pre-approved) system or site would simply eliminate the need for agency re-review. The COL would become the final agency action.

Summary

Permit me, Mr. Chairman, to summarize my remarks as follows:

- Modernization of the nuclear licensing and regulatory process is necessary to preserve a vital energy option, and to sustain and enhance the nuclear industry's excellent safety record; both objectives are served by reform legislation.
- The public health and safety goal is served:
  - by focusing the nation's technical resources (both in industry and in the regulatory body)

on fewer, standardized plants or systems, as opposed to squandering our technical resources on a plethora of custom designs;

- by more effective public participation, early in the process before major financial resources are committed, and public participation with essentially complete designs and siting proposals in hand; and

- by a more systematic review of retrofit proposals to assure that the net overall plant safety is enhanced, not degraded, by such proposals.

o The interests of investors, the utilities, and the suppliers will be served by a more stable regulatory environment; and, again, the public will benefit, from lower energy prices;

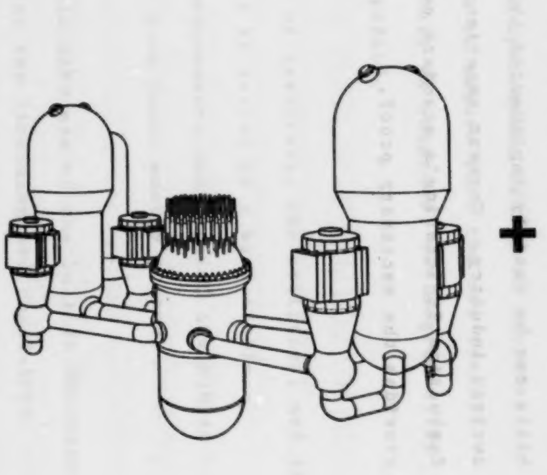
o Congress should make use of the lull in NRC case load to perfect the licensing and regulatory process, rather than wait for a future in which pressures constrain reason or, worse, a future when remobilization of nuclear energy is no longer an alternative. The time for deliberate, careful Congressional consideration is now.

- The major outlines of the bills before Congress now are quite similar, differing only in emphasis and refined accommodations of checks and balances; debate over the past few years has served to converge the various proposals; therefore, I believe that Congress can efficiently move legislation through markup and develop a single bill that can be enacted during this session.

- The standardization provisions of the proposed bills can be readily implemented by the NRC and nuclear industry. Current experience with Combustion Engineering's standard design clearly provides the necessary proof.

FIGURE 1

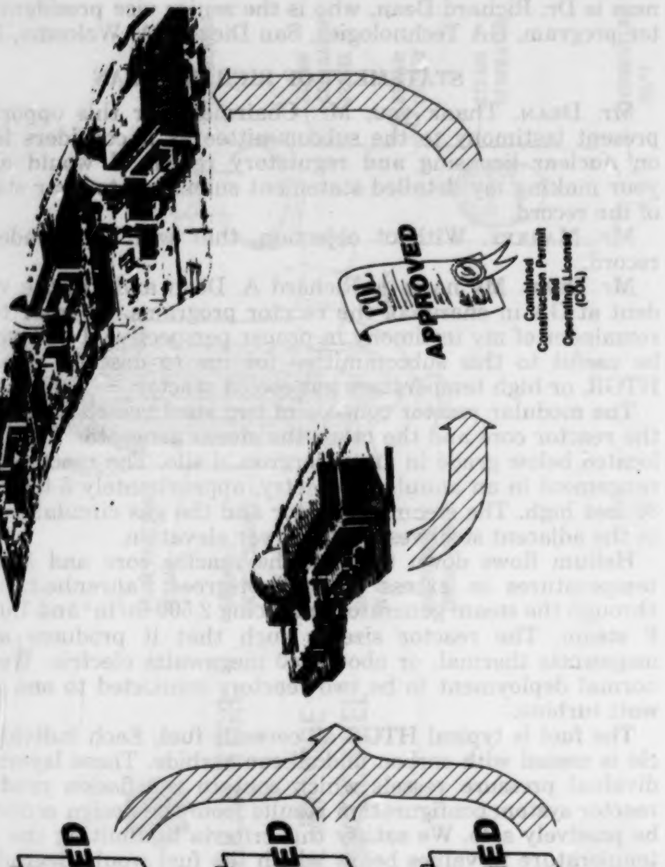
NUCLEAR STEAM SUPPLY SYSTEM



SCOPE OF SUPPLY

- Reactor Vessel Internals and Core Supports
- Fuel Assemblies
- Special Handling Equipment for Fuel and Reactor Vessel Internals
- Control Element Assemblies
- Control Element Drive Mechanism Power Supply
- Pressurizer Heaters and Control
- Pressurizer Safety Valves
- Equipment Supports
- Emergency Core Cooling System
- Main Control Room Panel Board and All Integral Equipment
- Process Instrumentation and Controls
- Instrumentation and Control Equipment Racks and Panels
- Reactor Protective Systems
- Supplementary Protective System
- Reactor Control Systems
- Neutron Monitoring System
- Chemical and Volume Control System
- Shutdown Cooling System
- Containment Spray System
- Spray Chemical Addition System
- Engineered Safety Features Actuation System
- Startup Test Program for NSSS
- Safety Analyses
- Design Provisions for Inservice Inspections

FIGURE 2


CERTIFIED
Balance of Plant
CERTIFIED
Site
CERTIFIED
Design Certification
COL
APPROVED
Combined Construction Permit and Operating License (COL)

Mr. **Markey**. The gentleman's time has expired. Our next witness is Dr. Richard Dean, who is the senior vice president for reactor program, GA Technologies, San Diego, CA. Welcome, Dr. Dean.

STATEMENT OF RICHARD DEAN

Mr. **Dean**. Thank you, Mr. Chairman, for this opportunity to present testimony to the subcommittee as it considers legislation on nuclear licensing and regulatory reform. I would appreciate your making my detailed statement submitted to your staff a part of the record.

Mr. **Markey**. Without objection, that will be included in the record.

Mr. **Dean**. My name is Richard A. Dean and I'm the vice president at GA in charge of the reactor programs. In order to put the remainder of my testimony in proper perspective, I believe it would be useful to this subcommittee for me to describe our modular HTGR, or high temperature gas-cooled reactor.

The modular reactor consists of two steel vessels, one containing the reactor core and the other the steam generator. Both would be located below grade in an underground silo. The reactor core is arrangement in an annular geometry, approximately 3 feet thick and 30 feet high. The steam generator and the gas circulator is located in the adjacent steel vessel at a lower elevation.

Helium flows down through the reactor core and is heated to temperatures in excess of 1,250 degrees Fahrenheit, and then through the steam generator producing 2,500 lb/in^2 and 1,000 degree F steam. The reactor size is such that it produces about 350 megawatts thermal, or about 140 megawatts electric. We envision normal deployment to be two reactors connected to one 280-megawatt turbine.

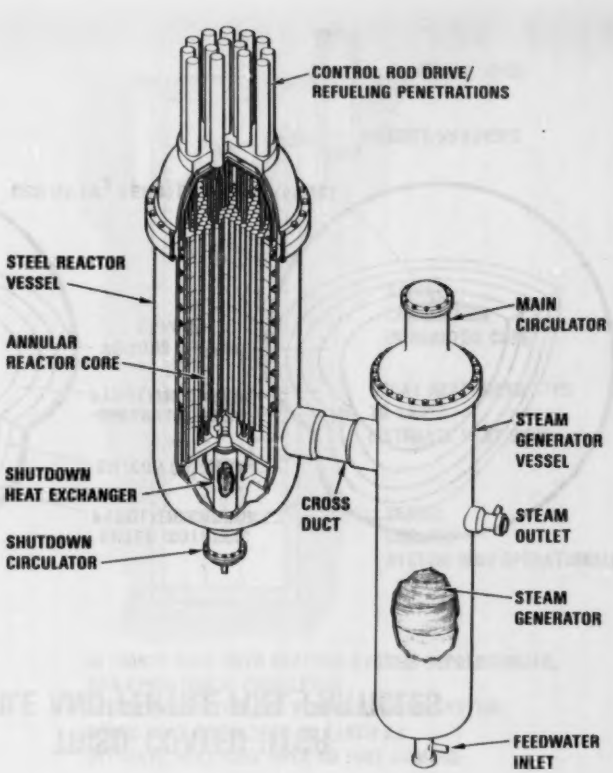
The fuel is typical HTGR all-ceramic fuel. Each individual particle is coated with carbon and silicon carbide. These layers form individual pressure vessels which contain the fission products. The reactor system configuration results from the design criteria that it be passively safe. We satisfy this criteria by limiting the peak fuel temperature to values below which the fuel would degrade and release those fission products.

This is accomplished by removing the heat under extreme accident conditions to the Earth as the ultimate heat sink without any forced cooling. By designing the plant in this manner, we are able to eliminate the engineered safety systems that have been added to most nuclear plants to protect the public during postulated accidents.

[Viewgraphs of the items described follow herewith:]

MODULAR HTGR

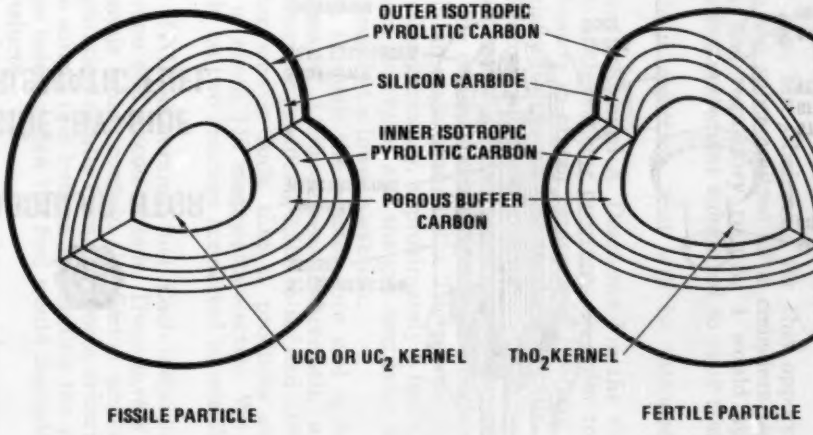
SIDE–BY–SIDE PRISMATIC FUEL


CONTROL ROD DRIVE/
REFUELING PENETRATIONS
STEEL REACTOR VESSEL
ANNULAR REACTOR CORE
SHUTDOWN HEAT EXCHANGER
SHUTDOWN CIRCULATOR
CROSS DUCT
MAIN CIRCULATOR
STEAM GENERATOR VESSEL
STEAM OUTLET
STEAM GENERATOR
FEEDWATER INLET

H-353(1)
8-15-85

GA Technologies

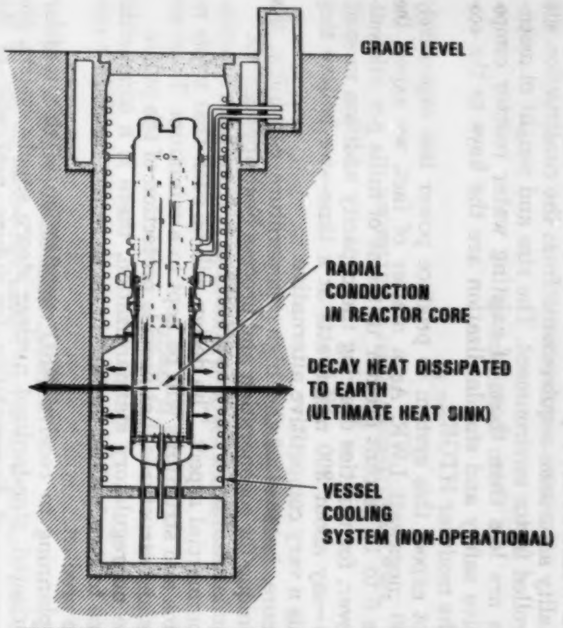
TRISO-COATED HTGR FISSILE AND FERTILE FUEL PARTICLES


OUTER ISOTROPIC PYROLITIC CARBON
SILICON CARBIDE
INNER ISOTROPIC PYROLITIC CARBON
POROUS BUFFER CARBON
UCO OR UC2 KERNEL
ThO2 KERNEL
FISSILE PARTICLE
FERTILE PARTICLE

N 140

GA Technologies

MRS CORE COOLING WITH EARTH AS HEAT SINK IN ULTIMATE ACCIDENT CASE


GRADE LEVEL
RADIAL CONDUCTION IN REACTOR CORE
DECAY HEAT DISSIPATED TO EARTH (ULTIMATE HEAT SINK)
VESSEL COOLING SYSTEM (NON-OPERATIONAL)

ULTIMATE CASE WITH REACTOR SYSTEM DEPRESSURIZED,
NON-OPERATIONAL CIRCULATOR,
STEAM GENERATOR AND VESSEL COOLING SYSTEM.
DECAY HEAT CONDUCTED TO EARTH AS
ULTIMATE HEAT SINK WITH NO FUEL DAMAGE

G-578(5)
3-15-84

This NSSS would be factory fabricated, transferring many of the rigorous quality assurance requirements from the construction site to the controlled factor environment. The size and weight of assembled vessels are less than those of existing water reactor components. Passive safety and standardization are the keys to the economics of the modular HTGR.

We do not expect this system to produce power less expensively than a 1100 megawatt LWR. As a matter of fact, we expect the power to be 5 to 10 percent greater in terms of mills per kilowatt-hour. However, for utilities desiring the capacity addition in small increments—say about 300 megawatts at a time—we believe they will find this a very competitive alternative.

Furthermore, because of the high temperature capability, this system is unique for cogeneration and process heat applications.

As to standardization, we are approaching it from both a regulatory and commercial aspect. The design will be such that safety related systems and structures will be kept to a minimum. These are the systems and structures that provide protection of the public.

As to the nonregulatory standardization, there is a commercial driving force to standardize. Failure to do so would result in a noncompetitive product.

We are planning to receive NRC certification of this modular, factory fabricated, standardized nuclear steam supply system, providing assurance of licenseability for future replicates of this design. The only customizing envisioned is the design of the plant for high seismic sites, and we hope this will lead to a single, high-seismic standardized design.

Our current objective is to continue with the effort on the modular HTGR, such that we can make commercial offerings in less than 10 years.

To conclude my remarks, Mr. Chairman, GA Technologies is a strong supporter of standardization in modularized designs. The scope of the regulatory standardization program should be limited to those subsystems and structures that protect the safety and health of the public from the consequence of accidents.

The licensing approval of regulatory standardized designs for construction and operation by via one step licensing may be expensive and time consuming, but once accomplished, it will also curb the proliferation of minor changes either by the vendors or the NRC. This should make construction and operation of nuclear powerplants commercially attractive and increase their acceptability to the general public.

Thank you for the opportunity to present these views. I would be pleased to answer any questions.

[The prepared statement of Dr. Richard Dean follows:]

STATEMENT OF R. A. DEAN

GA TECHNOLOGIES INC.

TO THE

SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

OF THE

COMMITTEE ON ENERGY AND COMMERCE

U. S. HOUSE OF REPRESENTATIVES

DECEMBER 10, 1985

OBJECTIVE OF GA TECHNOLOGIES' TESTIMONY:

To have the Subcommittee support legislation which would endorse standardization as part of one-step licensing and regulatory reform.

Thank you, Mr. Chairman, for the opportunity to provide testimony to this Committee as it considers legislation on nuclear licensing and regulatory reform.

My name is Richard A. Dean. I am Vice President of GA Technologies, responsible for Reactor Programs.

This statement, which is submitted for inclusion in the hearing record, provides an overview of GA Technologies activities as a Nuclear Steam Supply System (NSSS) vendor, an update on the High Temperature Gas Cooled Reactor (HTGR) Program, and specific responses to the questions relating to nuclear power plant standardization contained in your invitation. My short oral presentation will concentrate on your primary interest of nuclear power plant standardization.

Development of the HTGR concept was started in the United States by General Atomic (a predecessor company) in 1958 based upon a broad foundation of gas cooled reactor technology from Europe. The program has benefited from a continuing base of utility support and guidance since its inception in the U.S. That utility role is currently performed by Gas Cooled Reactor Associates (GCRA), a utility supported and managed organization comprised of approximately 30 electric utilities representing approximately one-third of the generating capacity within the United States. In addition, the GCRA organization also has active members representing the process industry where the interest in the HTGR is in its co-generation and process heat application.

Major milestones in the HTGR program have included the design, construction, and operation of the Peach Bottom 1 HTGR on the system of the Philadelphia Electric Company.

The second major HTGR project, which also included government participation, was the 330 MW(e) Fort St. Vrain Nuclear Generating Station which was built for and operated on the system of Public Service Company of Colorado.

Subsequent to the one of a kind Peach Bottom and Fort St. Vrain projects, five twin unit plants in the 770 to 1170 MW(e) range were sold by GA to United States utilities. These were modular loop-type plants incorporating various numbers of standardized systems and subsystems to accommodate the different plant outputs. For example, the steam generators and gas circulators were identical for all the plants involved. All of these projects were subsequently cancelled or the sales withdrawn as a result of the collapse of the commercial nuclear market and the economic effect on utilities triggered by the OPEC oil embargo and the resulting recession. Following the cancellation of those commercial projects of the mid-1970s, joint programs sponsored by the Department of Energy and industry focused on the design, development, and optimization of large HTGR plants in the range 860-1200 MW(e). The concepts of modularization and standardization continued to be used extensively in these efforts.

Over the past two years, the HTGR program has been refocused on a smaller, simpler, passively safe, modular HTGR. This type of small modular plant appears to be more responsive to meeting the current nuclear industry problems such as lower load growth, cost and schedule uncertainties, and investment risk. This single design has been selected by the participants in the DOE program with a major goal to standardize the design for commercial replication. A licensing document will be submitted to NRC in mid-FY'86 and the DOE Licensing Plan incorporates a demonstration module (350 MWt) for construction in the early '90s and for certification of the standardized design. Due to the specific characteristics of the small modular HTGR, this standardized design makes use of passive features which have fewer uncertainties placed upon the safety related subsystems.

With this background, I will now address your specific requests regarding standardization as contained in your invitation:

1. What is power plant design standardization intended to achieve?
2. How is standardization intended to work?
3. What is the level of design detail required for approval?
4. How are changes to standard designs to be handled?
5. Does standardization require complete plant designs or can standardized subsystems be included?

My responses to the specific fifteen questions attached to your invitation have been provided to your staff. Those responses, as well as comments that I will make on the above five items, are based on the following approach to standardization.

It is my belief that power plant standardization is comprised of two interfacing but separate parts: Regulatory Standardization and non-Regulatory Standardization.

The scope of Regulatory Standardization is limited to those that protect the health and safety of the public from consequences of accidents. This includes only the safety related subsystems and associated structures required to meet 10CFR100 dose limits. It would also require assurance through analysis backed up by adequate testing that these subsystems and structures can perform the plant's safety functions. The accomplishment of defined safety functions of the plant would be assured through performance specifications for the affected subsystems.

The scope of non-Regulatory Standardization would include most non-safety related subsystems and associated structures and the way in which these subsystems and structures are used to satisfy the total plant's functions of generating reliable economical energy. These non-safety related subsystems and related plant configurations would not be controlled via Regulatory Standardization since they do not impact the safety and health of the public regarding accidents, but standardization would, I believe, be of considerable interest to suppliers, customers, regulatory agencies and others from the point of view of assurance of reliable energy being supplied at a competitive price.

What is standardization supposed to achieve? The advantage of Regulatory Standardization of safety-grade subsystems lies in the ability to use such subsystems in a new plant as a "standard part" where its design details and performance characteristics have already been established. Regulatory standardization can be expected to lead to significant improvements in the safety, operation, and economics of nuclear plants as well as supporting the simplification and effectiveness of the regulatory process. It should develop a more disciplined review process without the need for in-depth re-reviews of the applications. Conservation of the resources of designers, engineers, contractors, operators, and all others involved in a nuclear plant project are expected to be achieved.

The benefits from non-Regulatory Standardization control can be equally significant. The industry has first-hand knowledge of the pitfalls of one of a kind designs for plants. Modularized, skid mounted systems, factory fabricated packages, minimum field construction, and replication are the design philosophy being used today by all A/Es and vendors. Standardization, as used in other product lines, is a must for a re-establishment of the nuclear industry. It is a well established fact that ability to meet schedules and costs and, more importantly, quality and therefore reliability can be improved through replication of a proven standardized design.

How is standardization intended to work? In a mature licensing environment, an applicant would submit a detailed plant design to obtain a one-step license to construct and operate (CP/OL). The plant design would include a standard certified design for the safety-related subsystems along with associated structures. This would permit an expeditious and efficient review of the application by NRC. After approval, these Regulatory Standard designs for subsystems and structures could be incorporated in subsequent plant designs and would not be subject to detailed NRC review. The certification process would also provide an incentive to the industry to simplify and standardize the number of such systems in a plant.

What level of design detail should be required for approval? The level of design detail required to receive a standardized design certification should be that normally required for final design approval. This level of detail is also that normally required in order to perform the safety analyses that define the risk to which the plant can expose the public. The level of design detail of a safety-related subsystem would necessarily include the data required for the NRC to assess the ability of the system to meet its prescribed functions and requirements. This could require test data on the subsystem involved as well as design calculations.

How are changes to standardized designs to be handled? A "Regulatory Standardized" design should remain valid and reusable indefinitely or until one of the following occurs:

1. The standardized subsystem is shown to not meet its Regulatory performance functions or requirements.
2. The standardized subsystem design is changed to take advantage of state-of-the-art advances; i.e., new materials, components, etc. that changes its Regulatory performance characteristics beyond approved limits.

3. The standardized subsystem cannot meet more stringent safety criteria imposed by any formally changed NRC regulations.

Changes to Regulatory Standardized designs would be submitted for approval as amendments. These submittals would be reviewed by the NRC to determine if the updated or revised subsystem still meets its prescribed function without adverse impact on the rest of the safety grade subsystems. If there is no adverse impact, it should be approved as a later model of the same standardized design approved originally. If it does adversely impact the overall safety level of the plant, a new standardized design approval should be required.

The period of ten years, as proposed in the pending Congressional bills, is a minimum and unnecessarily arbitrry. It forces unnecessary review where only a few plants may be built in that time frame, and it does not allow for technology advances that come along before a ten year period is over. A "standard part" should be standard for as long as it is shown to be able to perform its intended function. A fixed period of time should be replaced by NRC verification that approved Regulatory Standardized designs continue to meet performance requirements in operating plants.

Does standardization require complete plant designs or can standardized subsystems be included? As indicated in my earlier comments on the scope of Regulatory Standardization, standardization should be at the subsystem level. In order to handle the numerous interfaces between a nuclear plant's components, it has always been a convention of good engineering management to subdivide a plant into systems and/or subsystems in such a way as to minimize the interfaces involved in the design work. In part, due to this subdivision for minimum interfaces, the subsystems are usually very complete and self-contained packages for design, construction, and operation. Consequently, standardization of subsystems is a natural level to select for approval. However, the way in which several subsystems work together will have a major bearing on the overall standardization of the safety-related subsystems and their associated structures. Both levels (plant and subsystem) have to be considered in any standardization activity.

Permit me, Mr. Chairman, to summarize my remarks:

GA Technologies is a strong supporter of standardization and modularized designs, and has many years of design activity working towards this goal. The scope of a Regulatory Standardization program should be limited to those subsystems that protect the safety and health of the public from consequences of accidents. Various features of a nuclear plant must become standardized by the industry to ensure a competitive product. Licensing approval of Regulatory Standardized designs for construction and operation via one step licensing may be expensive and time consuming, but once accomplished, it will curb the proliferation of minor changes either by the vendors or by NRC retrofitting actions. This should help to make construction and operation of nuclear power plants commercially attractive as well as acceptable to the general public.

Your Committee's activities are most important to the nuclear industry. It is my hope that the information I have provided will assist you in getting an improved nuclear licensing and regulatory process bill developed and passed.

Mr. MARKEY. The gentleman's time has expired. There is a rollcall on the floor of the House right now, with 8 minutes remaining. We are going to take a brief recess for about 10 minutes. We will reconvene and hear the testimony from the final two witnesses, and then go to questions from the subcommittee.

[Recess taken.]

Mr. BRYANT. The Subcommittee on Energy Conservation and Power will resume its hearing on the standardization of nuclear powerplant designs.

It is my understanding that when we recessed to go vote, we were ready to hear the testimony of Mr. Stanley Jacobs, vice president, Stone & Webster Engineering Corp.

STATEMENT OF STANLEY JACOBS

Mr. JACOBS. Thank you, Mr. Chairman. I would like my detailed statement included in the record.

Mr. BRYANT. Without objection, so ordered.

Mr. JACOBS. I am pleased to appear here to express the views of Stone & Webster on nuclear powerplant standardization. Stone & Webster is a pioneer on nuclear powerplant standardization.

We are firmly convinced that standardization and related measures will ensure adequate safety, while creating an environment of predictability and reasonable certainty as to the licensing process. Such improvement is essential to a climate in which utilities will once again consider ordering nuclear powerplants.

Because about half the cost of a plant is a function of the time involved, as reflected in interest and inflation, it is imperative to bring greater stability to the overall process.

We began our efforts on standardization in the late 1960's, and have participated in the NRC standardization program since its inception in 1972. We were the first engineer-constructor to receive standardized balance of plant preliminary design approvals from the NRC. Attaining our first preliminary design approval was the result of a commitment of hundreds of our engineering and design personnel over a decade, to a project solely dedicated to this referenced design.

This effort included not only development of engineering, but also construction planning to ensure that the design was as efficient to construct as possible.

Since receipt of the preliminary design approval in May 1976, we have had our balance of plant design approved relative to two additional reference nuclear steam supply system designs, and requested approval for a fourth. These approvals required additional engineering of our reference design to provide the proper match with the particular nuclear steam supply system. Even with this additional engineering, the vast majority, about 90 percent, of the balance of plant was maintained as a single standard design.

Our reference design was used in the first application for a construction permit which incorporated both previously approved nuclear steam supply system and balance of plant reference designs.

Standardization consists of reference designs, approved by NRC, independent of site or license application. Under such an approach, the developer of a design would submit a safety analysis report with an application for a design approval. The application could describe a nuclear steam supply system or a balance of plant, as was the practice under the reference system option of existing NRC standardization policy. An entire plant could also be described.

We endorse the use of a balance of plant matched with a nuclear steam supply system, because it is consistent with the well-tested and longstanding practices in the power industry. Also, the use of this approach will ensure that the significant amount of expertise now within existing engineer-constructor and reactor manufacturer organizations would not be lost.

An appropriate base for standardization to build upon is available in today's plants. The level of safety of these plants is already quite high. The extreme level of conservatism present is evidenced in the available documentation that shows that the amount of radioactivity assumed to be released in the plant in a postulated accident, the so-called nuclear source term, is considerably overstated.

An important aspect of both the standard design and the single stage licensing process is determining the extent and level of design information necessary for NRC to determine that a plant or major subsystem is designed and can be constructed and operated in conformity with the provisions of the Atomic Energy Act and the NRC's rules and regulations.

We believe there is a level of design information sufficient and reasonable for the NRC to reach a conclusive safety determination. The appropriate design level requires criteria and standard specifications and design methods which are verifiable by the NRC, as necessary, during procurement and implementation of the design.

Detailed design documents, such as calculations for cable tray loads and drawings for items such as pipe supports, are used primarily in the construction phase rather than the initial phase and need not be submitted as part of the approval process. They would be checked after procurement of hardware.

Nuclear plant standardization must carry with it the discipline of regulatory stability. This discipline must be exercised by everyone concerned with the engineering, design, licensing, and construction of a nuclear powerplant. "Everyone" means the utility, the engineer-constructor, the reactor manufacturer, and Federal and State regulatory authorities.

Regulatory stability is needed to impose order on the process of changing a nuclear plant design. Undisciplined change prevails under the current multistage licensing process. Undisciplined change comes from changes in regulatory requirements, from a better mousetrap approach to engineering and design, and from a change in basic design. However, a marginal or unnecessary change never remains minor.

Efforts previously performed must be undone and redone. The purported cost and schedule benefits of the change are quickly lost.

[The prepared statement of Mr. Stanley Jacobs follows:]

STATEMENT OF
STANLEY B. JACOBS, VICE PRESIDENT
STONE & WEBSTER ENGINEERING CORPORATION
BOSTON, MASSACHUSETTS

SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER
COMMITTEE ON ENERGY AND COMMERCE
U.S. HOUSE OF REPRESENTATIVES

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Mr. Chairman and members of the Subcommittee:

My name is Stanley B. Jacobs and I am a Vice President and Engineering Manager of Stone & Webster Engineering Corporation. I am pleased to appear before your Subcommittee to express the views of Stone & Webster on nuclear power plant standardization. Stone & Webster is a pioneer in nuclear plant standardization. We began our efforts on standardization in the late 1960's and have participated in the NRC standardization program since its inception in 1972. We were the first engineer-constructor to receive standardized balance of plant Preliminary Design Approvals from the Nuclear Regulatory Commission (NRC).

Having been involved in nuclear power for more than 25 years, I have long been convinced of the need for standardization. As a result, I have become an ardent proponent of standardization and a firm believer that the significant incentives for standardization--such as improved assurance of safety and enhanced utilization of resources--are realizable in a practical way. In addition to my participation in developing a standardization program at Stone & Webster, I have served as Chairman of the Atomic Industrial Forum

Subcommittee on Standardization and have participated in many other industry-wide standardization activities.

I previously testified, on these issues before you today, before the Subcommittee on Energy and the Environment, Committee on Interior and Insular Affairs in May, 1981.

We are firmly convinced standardization and related measures will assure adequate safety while creating an environment of predictability and reasonable certainty as to the licensing process. Such improvement is essential to a climate in which utilities will once again consider ordering nuclear power plants. Because about half the cost of a plant is a function of the time involved -- as reflected in interest and inflation -- it is imperative to bring greater stability to the overall process.

Attaining our first Preliminary Design Approval was the result of a commitment of hundreds of our engineering and design personnel over a decade to a project dedicated solely to this reference design. This effort included not only development of engineering, but also construction planning to ensure that the design was as efficient to construct as possible.

Since receipt of the Preliminary Design Approval in May, 1976, we have had our balance of plant design approved relative to two additional reference nuclear steam supply system designs and have requested an approval for a fourth. These approvals required additional engineering of our reference design to provide the proper match with the particular nuclear steam supply system. Even with this additional engineering, the vast majority of the balance of plant was maintained as a single standard design. Our reference design was used in the first application, submitted by New York State Electric & Gas Corporation and Long Island Lighting Company, for a construction permit which incorporated both previously approved nuclear steam supply system and balance of plant reference designs. The application was, unfortunately, withdrawn by the utility due to reduced power demand.

We also have been active in other types of standardization programs such as the NRC Topical Report Program. We have received NRC approval for topical reports on subsystems for the reference nuclear power plant, on an independent spent fuel storage facility, and on various software. In addition, we were the first engineer-constructor to receive, in 1974, NRC approval for a standard nuclear quality assurance program. We also have standardized our construction methods and procedures, such as material controls, handling and storage, steel erection, and concrete placement.

The current statutory licensing procedures were developed when the nuclear industry was getting started. This process has proven to be cumbersome, lacking in stability, and unnecessarily costly to the consumer, the regulators, and the industry. In this regard, the present licensing process diverts scarce regulatory and industry resources from uses that would better serve the consumer. Thus, standardization is greatly needed to combat inefficiencies in the current regulatory regime.

Standardization consists of reference designs, approved by NRC, independent of site or license application. Under such an approach, the developer of a design for a nuclear plant or major portion of a plant would submit a Safety

Analysis Report with an application for a Design Approval. The applicant could be either a reactor manufacturer, an engineer-constructor, a utility, or any combination of these. The application could describe a nuclear steam supply system or a balance of plant, as was the practice under the reference system option of existing NRC standardization policy. An entire plant could also be described as was done under the manufacturing license, duplication, and replication options of this NRC standardization policy.

We endorse the use of a balance of plant matched with a nuclear steam supply system, because it is consistent with the well-tested and long-standing practices in the nuclear industry. Also, the use of this approach will ensure that the significant amount of expertise now within existing engineer-constructors and reactor manufacturers would not be lost and there would be no loss of continuity due to the loss of this expertise in maintaining safe operation of plant designs already in use.

The many benefits of standardization can best be realized through use by all of the qualified participants in the nuclear business. Legislation, therefore, should direct rather than merely authorize the NRC to establish procedures for approval of both facility and major subsystem designs. This will ensure establishment of procedures to provide maximum flexibility and uses of pre-approved designs.

An appropriate base for standardization to build upon is available in today's plants. The level of safety of these plants is high. The extreme level of conservatism present is evidenced in the available documentation that shows the amount of radioactivity assumed to be released from the plant in a postulated accident - the nuclear source term - used in the design of these plants is considerably overstated.

An important aspect of both the standard design and the single-stage licensing process is determining the extent and level of design information necessary for the NRC to determine that a plant or major subsystem is designed, and can be constructed and operated, in conformity with the provisions of the Atomic Energy Act and the NRC's rules and regulations. We believe an in-between level of design information; i.e., a considerably greater level of detail in many areas than a current Preliminary Safety Analysis Report but less than a current Final Safety Analysis Report, would be sufficient and reasonable for the NRC to reach a conclusive safety determination. The detailed design documents such as calculations for cable tray loads and drawings for items such as pipe supports are used primarily in the construction phase rather than the initial phase and need not be submitted as part of the approval process. They also must be checked after procurement of hardware. The appropriate design level requires criteria and standard specification and design methods which are verifiable by the NRC, as necessary, during procurement and implementation of the design.

Nuclear plant standardization must carry with it the discipline of regulatory stability. This discipline must be exercised by everyone concerned with the engineering, design, licensing, and construction of a nuclear power plant. "Everyone," in this case, includes the utility, the engineer-constructor, the reactor manufacturer, and federal and state regulatory authorities. After millions of dollars have been spent developing a standardized reference plant, few benefits are gained when that design is revised. Regulatory stability is needed to impose order on the process of changing a nuclear plant design. Undisciplined change prevails under the current multi-stage licensing process; undisciplined change comes from changes in regulatory requirements, from a "better mousetrap" approach to engineering design, and from a change in basic design. However, a marginal or unnecessary change never remains minor. Efforts previously performed must be undone and redone, and the cost and schedule benefits of standardization are quickly lost. Too often changes imposed on a plant are not justifiable in terms of public safety or of cost effectiveness. Unnecessary change has occurred frequently in the past when regulatory requirements were changed after issuance of a permit or license and the licensee was required to adhere to new rules. It is the combination of standardized reference designs and change control that will establish the much needed stability in the licensing process.

It has been proposed, and it appears arguable as a legal matter, that many of the concepts of standardization could be achieved through administrative action.

I submit that because the concepts would be departures from long-standing policy and practice, they would likely encounter considerable resistance and, perhaps, challenge in the courts. Other aspects clearly require changing the law, such as the single-stage hearing for a Construction and Operating License. Given this situation, we are convinced that making all of the changes by law will ensure maximum certainty in the minimum of time, which is our common goal.

Legislation is necessary to provide the discipline discussed above and to provide for the long-term policies which would transcend individual philosophies within NRC and the nuclear industry. Administrative reforms alone, involving the exercise of discretion by NRC, have proved to be insufficient. In our view, it is important that Congress clarify its position and take a leadership role to provide the legislation required to stabilize nuclear regulation and licensing. In simplistic terms, Congress must express its intent and provide the legislative impetus to make it happen. Careful use by the NRC of the recently enacted backfit rule for standard designs also will provide stability for such designs.

It is in the public interest to weigh any enhancement in the overall level of health and safety to the public against the cost to the public. This balancing will greatly stabilize design and site approvals and enhance standardization. It will also stabilize the entire industry, from plants under construction to plants in operation. Proper backfit requirements are basic to the continued viability of the nuclear industry and should be applied throughout all phases of design, construction, operation, and regulation. In this light, the DOE bill backfit provisions are most appropriate.

I believe that the standardization process would be substantially enhanced by enactment of any one of the legislative proposals before you now with maximum benefit coming from a combination of the best features of each. For instance, we endorse the "conclusiveness" of design approvals provided by the DOE bill, H.R. 2488, as it would prevent repetitive litigation. Additionally, the criteria to be applied in approving changes to such design approvals are more appropriate in the DOE bill in that they are more consistent with the principles of standardization. Similar provisions are accorded the approval of a site by the DOE bill only.

A standardized design approval or certification should be effective for an initial period of ten years with a presumption in favor of allowing the approval or certification to remain in effect following its initial 10-year term, unless significant new information would preclude such an extension. This time period is consistent with the time frames associated with significant analytical or design innovations and incorporation of operating plant experience.

The industry, especially the utility sector, needs a clear and strong statement that the current licensing morass will, in fact, be eliminated. While granting that many of the bills' proposed improvements appear to be administrative in nature, confidence in a revised, stable licensing process can best be assured if such improvements are supported by an underpinning founded in law.

We appreciate the opportunity to present these views and express the hope that your Committee and the Congress will act soon to enact these improvements so important to ensuring the availability of nuclear power as a critical element in the nation's supply of electricity.

We continue to believe that nuclear power must play an important role in contributing to the nation's available electric energy capability. We are convinced that efforts to stabilize and bring predictability to the licensing process will advance the realization of that goal. We support enactment of this legislation and urge the Congress to act on this important matter.

This concludes my remarks on these bills, Mr. Chairman. I would be happy to respond to your questions.

Mr. **Bryant**. The gentleman's time has expired.

The Chair now recognizes our final witness, Dr. Lawrence Lidsky, who is professor of nuclear engineering at the Massachusetts Institute of Technology in Cambridge, MA. Welcome, Doctor.

STATEMENT OF LAWRENCE M. LIDSKY

Mr. **Lidsky**. Thank you, Mr. Chairman. I have included a statement for the record, where I ramble on at suitable professorial length. I want to do the skeleton of my argument here, and it is the following.

First, I would like to say that suitable nuclear technologies would lead to standardization by natural market forces, and not necessarily by legislation. The legislation here is focused on the light water reactor, but the light water reactor should not be the only technology at issue. It possibly should not be even the most important technology at issue.

The reason for that being first that we cannot standardize the existing plants. It is too late for that. It is not all clear that all of the new reactors will be LWR's, unless of course we legislate in such a way as to force that to occur. We must not set up unintentional barriers to more simple technologies coming into account.

What we see here is the result of very complex institutions interacting with very complex technologies, which is what the LWR is, and the end result is such things as the list of 15 questions that came with the call for this meeting. The public wants complex institutions. We have proven that time and time again. The only cure then for the problem then is to introduce a simple technology. Such simple technologies do exist and by their very nature, they offer a potential for a totally changed regulatory structure.

The M-HTGR is an example I will use. There may well be others.

Mr. **Markey**. M-HTGR?

Mr. **Lidsky**. The M-HTGR, the reactor that Dr. Dean described. Let me for now just say that there exist nuclear technologies that can be made absolutely passively inherently safe, so that no combination of internal mechanism failures or operator actions can lead to core damage. That is acknowledged to be true. The price you pay for absolute inherent safety is that sort of reactor is inherently limited to very small size. Until fairly recently, that was thought to be a disqualifying fault.

However, if you have a reactor that must be small and can be safe, then you open up the possibility of license by test, a whole new way of doing things for the nuclear industry, that is available only to small, passively safe reactors, because first they are small enough so you can afford to build the prototype and test it, and second, they will survive the test. Several tests can be applied and you can see where the license by test really does work.

There is a perfect analogy here to the aircraft industry, where one is issued an air worthiness certificate, after one has presented a full scale prototype of the airplane you would like to build. That makes sense to the reactor vendor as it does to the aircraft manufacturer because you expect to sell a lot of reactors because they are small.

One expects to certify the NSSS, the nuclear plant itself, independently of any of the details of the balance of plant, because it is inherently safe and no external forces can cause difficulty. If you have done that, then you do a lot of things to revive the nuclear option, but without the force of legislation. One instantly goes back to a commercial grade balance of plant, with a much shorter construction time and a much lower cost. One has predictable costs and schedules, because many plants are being produced.

There is a vastly reduced regulatory uncertainty because the way in which that plant is used is independent of the balance of plant and it has been tested in fine detail. However, the plants are still customizable. For example, you can use various numbers of nuclear steam supply modules, numbers from two to possibly a dozen or so. You can customize them with respect to redundancy. You can customize it with respect to layout. You maintain all the advantages of competition and multiple vendors without legislating it.

Finally, you standardize but you do not insist on progress stopping. If any particular vendor thinks he can produce a better prototype—with better commercial value—he can present that prototype for license by test, and introduce it into the market. That is just the way new airplanes get introduced. If, because he believes there is a big enough jump in safety or in economy or anything else, a vendor is willing to spend the several hundred million dollars necessary to bring that one to test, it is brought to test and introduced in the market.

Finally, the point I would like to make most strongly: standardization should not be imposed, if it is imposed at all, as if the light-water reactor were the only possible reactor. If we do that, the light-water reactor will become the only possible reactor.

[The prepared statement of Dr. Lawrence Lidsky follows:]

STATEMENT SUBMITTED FOR THE RECORD

of the

UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON ENERGY AND COMMERCE

SUBCOMMITTEE ON ENERGY CONSERVATION AND POWER

hearing on

NUCLEAR POWER PLANT STANDARDIZATION

by

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Nuclear Power Plant Standardization

Relevance of Advanced Reactors

This hearing is part of a twenty year history of attempts to rationalize the process of nuclear power plant licensing and regulation. The current situation is unsatisfactory to all participants--the legislature, the public, the industry and the NRC itself--but no resolution has been achieved nor is one in sight. Our failure is not due to lack of effort but rather to the extreme difficulty of the task: We are trying to apply an exceedingly complex institutional structure to an almost equally complex technology. We have no right to assume that there will be a simple resolution to such a problem and the fact that we have not found one should not be a surprise. The proper strategy in the present situation is not to go on with an unsatisfactory status quo or to force an unsatisfactory and inappropriate answer but rather to change the problem.

This hearing, in common with almost all others in the last 20 years is studying an attempt to change the institutions. History shows us the futility of such attempts: the American public wants a pluralistic system, with maximum public participation, clear division of powers, and multiple levels of safeguards and appeal. Unless there is a clear consensus, such a system can be slow, contentious, frustrating and inefficient. Nonetheless, except for the most immediate emergencies, it is the preferred mode of operation. It is correctly perceived that the "need to keep the nuclear option open" is not such an emergency issue. As a consequence, attempts to standardize the present complex technology, which effectively call for significant changes in political and commercial institutions, have little chance of success, even if all parties are convinced of the desirability of such action at this time.

The only recourse, if we cannot change our institutions, is to change the technology to one that is better matched to our existing institutions. The stakes are high enough that we could easily justify the effort to develop such a technology from scratch but, in fact, such a technology already exists; one that can trace its roots back to the earliest days of the nuclear era in the U.S., Great Britain and Germany. The technology I refer to below is a particular version of the High Temperature Gas Cooled Reactor, the so-called Modular HTGR. However, my goal here is neither to discuss the technical features of the MHTGR in detail nor is it to argue its merits with respect to other advanced reactor concepts. It is instead to:

> First, point out that a different, better matched technology can greatly simplify the application of our existing institutions; and
>
> Second, to argue that we must not, in our zeal either to regulate or to promote the LWR, inadvertently erect a structure that makes it difficult for substantially better systems to come into use.

The MHTGR, A Small, Passively Safe Reactor

It is possible to design a commercial power reactor with demonstrable, inherent, passive safety. In the case of the MHTGR, this is a direct result of the unique capability of the fuel to maintain its integrity and to contain fission products at extremely high temperatures. It is possible to take advantages of these properties to build a reactor that has no chance of a core damaging accident due to any combination of system failures and operator actions. [For example, not even the combined effect of complete loss of coolant and full withdrawal of all control rods would lead to core damage or to radioactivity release.] The price that one must pay for this exceedingly desirable feature is a strict limitation on reactor size. Absolute passive safety in the sense described above is apparently only attainable in reactors with thermal power output of about 250 MW, corresponding to an electrical power output below about 100 MW per unit. A nuclear power station would necessarily employ a number of these units as individual power modules to make up its total generating capacity. Design studies have been done for power plants employing from two to eight such units, each capable of being installed, maintained and operated totally independently of the others. It is this perceived use of small HTGR's as multiple, independent units rather than any particular property of the reactor itself that lends the adjective "modular" to its name, and the "M" to its acronym.

Suppose such a reactor were a commercial reality and that its inherent absolute safety could be convincingly demonstrated [I will discuss the second supposition shortly]. How far would such a reactor go toward meeting the goals of regulatory reform and how would it fit into the existing structures of U.S. electric utilities and the nuclear industry? It is my contention that such a reactor would allow us to achieve the major goals of regulatory reform proposals without the need to make major institutional change. I will also claim that the very knotty problem of maintaining the simultaneous advantages of competition and design standardization would have a very natural solution.

Design Certification

A recurrent theme of recent attempts at nuclear regulatory reform is the call for the adoption and implementation of "Safety Goals" and safety goal-based regulation. There is general agreement that such an approach, if it could be implemented, would have significant beneficial effects on the major failings of the current system--prescriptive regulation, over regulation, dilution of responsibility, seemingly arbitrary backfit requirements, and public mistrust. There is far less agreement upon the possibility of implementing the Safety Goals, of actually demonstrating that a particular reactor embodiment meets the agreed-upon Goals. In the case of the LWR, implementation of safety goal licensing will almost certainly mean significant reliance on the techniques and numerical results of Probabilistic Risk Analysis (PRA). Unfortunately, PRA is, by its very nature, incapable of conclusively proving that the goals have been met. The obvious solution to this dilemma is some form of License-by-Test. In the case of the LWR, this option is not realistically available because of:

a) the difficulty of proving, even in tests, that a complex, multi-element, defense-in-depth system will respond properly to all possible initiating events; and because

b) a full-scale LWR cannot survive the licensing-basis tests without significant core damage, even while successfully demonstrating that no public hazard will ensue.

In the terms popularized by PRA, the investment risk (core damage) is substantially greater than the public risk (significant radioactive release). The utilities' awareness of this, of course, is a prime factor in the flight from nuclear power.

On the other hand, the MHTGR is ideally suited to License-by-Test. The analogy to the Airworthiness Certificate granted by the FAA to proposed commercial aircraft is often quoted and is in fact quite applicable. The cost of building and testing a single prototype reactor module is quite comparable to that of testing a new commercial aircraft and, as in the case of the aircraft, the prototype module is expected to survive the test in useable form. However, there is an important difference in that the Design Certification in the nuclear case would apply only to the nuclear module and not to the complete Nuclear Power Plant. This has important ramifications.

The goal of License-by-Test is the conclusive demonstration that a properly-constructed nuclear module would have no impact on public safety, independent of the mode of utilization. It will therefore, be necessary to prove that the core can survive, without damage, any combination of external events such as loss of off-site power, loss of control, loss of coolant. In other words, it must be conclusively demonstrated that the NSSS meets the Safety Goals independent of the design features or construction quality of the balance of plant that the safety boundary is the physical boundary of the Nuclear Steam Supply Steam. If this can be achieved, then the most serious issues facing the regulators, the vendors, and the utilities would all be significantly and simultaneously alleviated.

License-by-Test is a technologically realizeable goal. There is ample evidence that the MHTGR can achieve this goal and similar claims have been made for some variants of the LMR. It suffices for this discussion only to postulate the existence of some reactor that meets License-by-Test requirements in order to demonstrate the effect of such a reactor on the need for legislative change of the Nuclear Regulatory Process. I list below some of the more obvious effects of the existence of a design certified NSSS of approximately 100 MW_e capacity:

a) The need for a nuclear grade balance of plant would be eliminated. Both the cost and time required for actual construction would thus be significantly reduced.

b) Nuclear power plants could still be customized with respect to total power output, arrangement of components, design tradeoffs between redundancy and availability, as is done now for fossil fuel plants.

c) Effect on total plant cost of unpredictability of NSSS cost and scheduling would be significantly reduced.

d) Uncertainty due to potential regulatory changes would be almost entirely alleviated.

e) Competition between architect/engineer construction teams on the basis of cost and plant design could be carried out with significantly more design freedom, i.e., the benefits of competition could be retained without concern for significant impact on public risk.

Standardization

First, it is important to point out that a standardized module does not mean that there will be standardized power plants. In this case, the analogy to the aircraft industry is somewhat stretched--the nuclear module plays the part of the jet engine, there is still a whole airplane to design around it.

The existence of a small number of different standardized modules would occur quite naturally as a result of market forces. The cost of a prototype reactor module is estimated to be similar to that of a prototype large commercial aircraft but the construction facilities and research necessary to produce the prototype reactor are probably significantly less costly. The cost of a prototype module for submission to Certification testing is, therefore, large enough to require a significant commitment by the industry, but not so large that a number of potential vendors or vendor combinations could not be expected to enter the market. A certified module would be by definition a standardized module; the manufacturer would naturally like to produce as many identical units as possible without the need for new prototype tests. However, this need not stifle competition or design improvement any more than it has done in other industries. If an existing or potential vendor thought there would be substantial commercial advantage to certification of an improved proprietary module, it could be submitted for Design Certification at any time. The essential point here is that design standarization is not achieved by legislation but by the natural application of market forces.

Current Status

The suppositions underlying these arguments are more than mere hypotheses. First, there is a substantial body of data, design studies and actual reactor experience supporting the detailed MHTGR design. The most notable is the AVR reactor, operating successfully in Germany since 1967, and the MHTGR studies growing out of that experience, by HRB and by KWU. In this country, the effort originally supported entirely by the group of utilities constituting the Gas-Cooled Reactor Associates is now benefiting from significant funding from the Department of Energy.

The U.S. HTGR program has established the modular HTGR as its reference design, and several groups are trying to decide how best to exploit its inherent safety features to ease current licensing requirements and to optimize its suitability for the U.S. utility market. The DOE-supported program is focused on development of a reference design for which a Preliminary Safety Information Document will be submitted to the NRC in 1986 for formal review.

The NRC itself is actively engaged in the search for better regulatory modalities. Here I would like to quote Mr. Vincent Boyer's recent (Oct. 31, 1985) testimony to the Subcommittee on Energy Research and Production of the House Committee on Science and Technology. Mr. Boyer, who chairs the Management Committee of the Gas-Cooled Reactor Associates, stated:

> "Finally, let me address ...., the commitment of NRC staff resources at an early stage to review advanced reactor design approaches. The most recent policy statement clearly addresses this by stating 'the Commission encourages the earlist possible interaction of applicants, vendors, other government agencies and the NRC to provide for early identification of regulatory requirements for advanced reactors and to provide all interested parties ... with a timely, independent assessment of the safety characertistics of advanced reactor designs'. True to their word, the NRC has established an Advanced Reactor Group as a focal point for such interaction. To date, the U.S. HTGR Program through DOE has had a number of interactions with this group, including

briefings and written submittals, all of which are being guided by our mutually agreed upon Licensing Plan. In the future, many more interactions are planned to which the NRC staff has committed its resources. To date, we are very pleased with the NRC's responsiveness to our third point and trust that adequate budget and manpower resources will be available as warranted by our submittals."

Conclusions

There are reactor types other than the LWR which would fit much more comfortably into existing institutional structures. Although I have concentrated here on the impact of the MHTGR, in part because it is the advanced technology with which I am most familiar, it is not my present intention to argue that it is the only or even the best choice for development [I would, of course, be only too happy to make that argument in the appropriate forum]. My object here is only to emphasize that in attempting to solve the problems associated with the regulation of existing light water reactors, we are focusing on a very narrow subset of possibilities. It is important that we do not let our concern with these very real problems adversely affect the possibility of significantly better technologies emerging, possibly in the very near future.

Mr. **Markey**. Thank you very much, Dr. Lidsky. That completes the opening testimony of our panel. Now we move to questions from the subcommittee.

Let me begin by asking all of the panelists one basic question. Why do we need legislation to achieve standardization?

Mr. Brewer, you have testified that Combustion Engineering, your firm, already has a complete standardized design under the current regime at NRC for your firm.

Isn't this a technical issue, not a legal one? Can't each firm in the country get a standardized plant approved by the NRC without having Congress legislate on this issue?

Mr. **Brewer**. Mr. Chairman, it is true that Combustion Engineering has in fact standardized its product and we have placed that product in the market. A Combustion Engineering standard plant is in operation. We would not like to have that product, however, viciated and diluted by this chronic design as you go method of licensing nuclear plants. We would like to have that design protected by the inclusion of a combined operating and construction permit feature of the legislation.

We are in full support——

Mr. **Markey**. That is a separate question, the one stop shopping for operating license and construction. I am talking about just the pure question of standardized design. Do you need to have legislation in order to——

Mr. **Brewer**. No. In fact, the legislation that is proposed does not mandate standardization. It allows the licensee the choice of presenting to NRC a standard design or a custom design.

Mr. **Markey**. Mr. Priory?

Mr. **Priory**. Mr. Chairman, I think standardization would imply that we will set a standard and stick to it. In the past, we have set any number of standards in the industry along with the regulatory authority, the consequence of which, as history will tell us, that we have been unable to stick to those standards. It is that part of these bills that we think will make standardization come about. You cannot have standardization without a stable regulatory environment.

Mr. **Markey**. Mr. Faden?

Mr. **Faden**. Mr. Chairman, we don't believe that legislation is at all necessary to bring about standardization. As I think or at least I understood the previous speaker to indicate, you can't force the industry to standardize when it doesn't want to. By the same token, NRC has all the legal authority it now needs to standardize designs.

Mr. **Markey**. I am trying to get the point clear. You are not advocating mandatory standardization then? It is optional standardization? Is that right?

Mr. **Priory**. I think the argument is that you cannot have standardization without the other stabilizing provisions. Once you agree on a standard and you proceed on down the road to construct a plant, that standard begins to change. I guess that is the point. They are dependent upon each other. You cannot have standardization without an assurance that standard will remain in tact.

Mr. **Markey**. Can we use a general standardized form? In other words, our goal here would be not to have 122 customized plants in the country. We are going to have one standardized design. We can tinker with it along the way.

Doesn't that kind of simplify the regulatory process by having a single plant design that then the regulatory process can deal with, tinker with and perfect, so that over the course of a period of years, you minimize the number of additional changes which have to be made?

I am trying to be helpful. It seems to me that simplifies your job and the regulatory job, rather than saying that each one of you can have your own design, but still having the NRC dealing with all these various and sundry different forms that come into it.

Mr. PRIORY. I cannot agree with you more. I think the fact that it may take on the order of $200 million to put forth enough information for a standard design certification, I believe the market force will tend to certainly limit the number of people. Given the history of nuclear power, it will certainly limit the number of people or consortiums that would be willing to go forward to try to secure a standard design certification.

Likewise, I think there would be a limited number of investors that would be willing to put up $200 million to allow that entity to go forward for standard design certification.

Mr. MARKEY. I understand that. At that point, don't you have a much better process in place, even if additional changes are required in that one design, that now you have a situation where you have perfected that design and now by the fourth plant or the fifth plant or the sixth plant, you have it down to a very bare minimum, the number of additional changes which would be required, since it isn't this infinite number of designs that the NRC has to deal with in their infinite imperfections, that is, the NRC.

Mr. PRIORY. I can't agree with you more that fewer is going to be better.

Mr. BREWER. Mr. Chairman, I think you have made the essential points behind our desire for this legislation, that focusing technical resources, the regulators' technical resources on fewer items rather than diverse individualized designs leads to greater safety. Moreover, having all the relevant safety design information present, up front, enhances public health and safety. The current design as you go process would be eliminated. That is deleterious to safety. You have made the point.

But it sounds like you are tending toward one national design, one reactor vendor?

Mr. MARKEY. In my mind, standardized means we really get it down so that if you want to get into the business of putting up plants quickly to deal with the national energy crisis, then you don't have all these companies out there competing with their own version of what a standardized form should be. You say, let's just have one. Otherwise, each company should be able to come in with their own standardized but still customized design and let them go forward on that basis.

You don't need legislation for us to do that. It seems to me you need legislation if you want us to kind of arbitrate the thing and bring it down to one, but if we are still going to have 6 or 8 designs out there and different technologies, maybe 10 or 12 altogether, then I don't know how Congress gets in the business of saying that each company should do this, this and something else. Only if you want us to come in and say one design, let's get the job done, let's get it down to 6 years and move forward, do you really need us.

Mr. **Brewer**. Mr. Chairman, I would not envision there being 10 or 20 standard designs in this country. The entry fee is so large and the market at this time is so poor, I cannot conceive of a large number of standardized designs at $100 or $200 million a pop being available in the near term.

Mr. **Markey**. Dr. Lidsky, did you have a comment on this? Am I advocating nuclear socialism here?

Mr. **Lidsky**. Nuclear monarchy, in fact. I have never seen the Government ever propose a design, a legislative design, for any technology that managed to survive for longer than about 15 minutes in the marketplace. Having the Government mandate a design or mandate a group of companies getting together on a design, I think it would probably be the biggest mistake we could ever make. A single design, of course, would come to the question of does Westinghouse or G.E. or Combustion choose to go out of business while somebody else makes the standardized design.

I think others are advocating having two or three or four standardized designs.

The problem that I see with the advocation of legislated standardization is that it flies counter to all the institutions set up over the years. The one thing that I think is clear, is that we will not give up those institutions unless there is a dire emergency. But there isn't a dire emergency. There isn't an energy crisis. There is even less a nuclear energy crisis.

The only people who really want nuclear power are the nuclear vendors. The public wants electricity, by whatever means that makes the most sense, whatever means they think they can control.

Therefore, I come back to my initial argument that the thing you have to do to solve this very complicated morass we find ourselves in, is to leave the system open to technologies that better fit our existing institutions. We have tried for years, we can't and, for the most part, we don't want to change our institutions.

Mr. **Markey**. I yield to the gentleman from Texas.

Mr. **Hall**. I totally disagree with you, Doctor, on your statement that the only people that want nuclear power are the vendors. I think that's an irrational statement and not consistent with the facts. You have a right to say anything that you want to here.

You oppose standardization, you and Mr. Faden. Yet, you oppose "a design as you go" practice. Are you suggesting that all these companies ought to just do away with their research and development? You don't think this bill cries out for that, do you?

Mr. **Lidsky**. No. Apparently, I haven't been clear enough in expressing myself. My point in arguing about nuclear power and public desires is that the public would like to have cheap, bountiful electric power, by whatever it deems to be the safest and best way to get cheap, bountiful electrical power. That need not necessarily be nuclear power although it can very well be.

I am a very strong advocate of nuclear power. I have worked in the field for 23 years. I hope to work on it a fair bit longer.

I think that is not the issue. We are not advising doing away with research and development. What we are saying is that there must be a better way to regulate. One much better way to regulate is to regulate by actual test of the prototype reactor you would like to license, much as we regulate airplanes. I think there would be far more detailed research and design before a company submits a prototype reactor costing several hundreds of millions of dollars to test, unless they are very sure that it would survive that test, and that all that work and all the design effort was going to come to fruition.

I think advocating this license by test achieves both the goals we are shooting for: keeping our existing systems, but also keeping the possibility open of admitting more advanced reactors as time goes on.

Mr. **Faden**. I'm not sure I have made myself clear either. We do not oppose standardization. In fact, we very strongly support it, and have for the past decade, probably more strongly than most people in the industry. We think the only way to solve a lot of the safety problems that have cropped up in actual practice, in the plants that are out there now, is to have a complete design, one that has been tested and adopted beforehand. The failure to do that, the "design as you go" process, has led to most of the cost overruns and the safety problems that have arisen.

We would want to get away from "design as you go" as fast as you can. Where we part company is that we don't believe this legislation is either necessary or desirable to achieve that goal.

Mr. **Markey**. My time has expired. The Chair recognizes the gentleman from California.

Mr. **Moorhead**. Thank you.

I want to also thank the members of the panel here this morning, especially my fellow Californian, who is from one of my favorite cities, San Diego. We are glad to have you here today.

Mr. **Dean**. Thank you.

Mr. **Moorhead**. Dr. Dean, many State utility commissions are imposing incentive programs on utilities, in order to encourage improved reliability. Will standardization have any effect on nuclear power plant reliability?

Mr. **Dean**. Yes, Congressman Moorhead. We believe that with the standardized design, you will get a significant improvement in the overall reliability. However, it comes to the marketplace from the different vendors, but once they have standardized, we expect, and from the studies that have been performed in other industries, you will get a significant improvement in reliability which then hopefully will allow these public utility commissions to move away from this prescriptive practice of imposing incentives in such instances.

Mr. **Moorhead**. Dr. Brewer, do you believe that backfitting provisions should be included in any licensing reform and standardization legislation by the subcommittee?

Mr. **Brewer**. Mr. Moorhead, yes, I do. I believe there has been in the past a backfitting process imposed by the Nuclear Regulatory Commission and it has failed. They now have a new backfitting rule which is very good on paper, but I worry about that failing, too, and not being put into practice.

For that reason, I believe placing the thing in statute is desirable.

Mr. **Moorhead**. Do any of the other members of the panel have any ideas on this particular question? Mr. Priory?

Mr. **Priory**. Yes, I do, Mr. Moorhead. Although we do have a backfit rule that recently has come into the forefront, there have been several different interpretations of the backfit rule that are very difficult for us to understand in the industry.

There has also been a challenge by the Union of Concerned Scientists as to whether the Commission has the authority to implement the benefit/cost provisions of the backfit rule.

I think what we are seeing is difficulty in handling of the backfit provisions as a rule made by the Commission. I think legislation would help to clear that up and provide a substantial amount of guidance, not only to the Commissioners, but also to those folks who are out there in hopes of building a plant for the future and looking for some assurance that investment will be well placed.

Mr. **Moorhead**. Thank you. Dr. Brewer, your testimony calls for a higher degree of standardization for the nuclear portion of the plant, the balance of the plant. What percentage of the design information for the nuclear portion of the plant should be available before the NRC approves the design?

Mr. **Brewer**. Essentially complete, Mr. Moorhead. In terms of the complete design and the engineering analysis which stands behind that design, we would anticipate submitting it to NRC up front.

Mr. **Moorhead**. Thank you. I have no further questions.

Mr. **Bryant**. The Chair recognizes the gentleman from Texas.

Mr. **Hall**. I will pass at this time, Mr. Chairman. Thank you.

Mr. **Bryant**. The gentleman from Utah.

Mr. **Nielson**. Thank you.

Dr. Brewer, do you think anything more than just the nuclear steam supply can be standardized? You seemed to emphasize that part. Can you standardize anything in addition to that?

Dr. **Brewer**. Mr. Nielson, I stressed that because the nuclear steam supply system is the heart of the safety consideration before NRC, and that must be standardized, fixed, stable, et cetera, procedurally.

I think Mr. Jacobs also indicated that his firm has standardized over 90 percent of the rest of the plant, the balance of plant, indicating that, too, can be done.

Mr. **Nielson**. A general question, I would like Mr. Priory, Mr. Faden and Mr. Lidsky to answer, if they will.

If the present designs are standardized, wouldn't future improvements to the plant's safety be discouraged?

Mr. **Faden**. We think there is that potential, Mr. Nielson, very definitely. That is why we are not comfortable with legislation that would restrict the NRC's authority to incorporate new data, new safety information, into its regulations. Unfortunately, the backfitting provision in these bills would have that effect.

We think the Commission has to have the flexibility to upgrade its designs, to take into account lessons it learns, and it is learning them all the time, and we think for that reason, it would not be wise for Congress to legislate in the backfitting area.

Mr. **Nielson**. Dr. Lidsky, would you like to comment on that question?

Mr. **Lidsky**. Yes, I would. I would like to come back for a second to the aircraft industry analogy that is proving so useful today. The aircraft industry is a perfect example, I think, of a place where standardization has occurred by natural market forces, yet there still exists backfit provisions.

I was reading just today how, by fiat, 747's will be backfitted with changes to their tail assembly. When it comes time that the FAA thinks it should be done, it still has the power to do that.

Mr. **Nielson**. Mr. Priory, do you think if we standardize the present designs, is that going to jeopardize safety?

Mr. **Priory**. I don't believe it will; no. I believe that the backfit provisions as they are written now allow for any significant safety provisions to pass right on through the backfit, if they are cost beneficial for the plant and for safety.

Mr. **Nielson**. Do you think the NRC plants that have been approved are sufficiently safe?

Mr. **Priory**. The NRC powerplants that have been approved?

Mr. **Nielson**. The plant designs that the NRC is presently approving, are they sufficiently safe to be used as a base for standardization? Is that a good starting point?

Mr. **Priory**. I believe that is a good starting point; yes.

Mr. **Nielson**. Would the rest of you comment on that?

Mr. **Brewer**. I certainly do, Mr. Nielson. Further, to answer your first question, the legislation, including the backfitting provision, does not handcuff the Nuclear Regulatory Commission from ordering backfits. It merely imposes a more systematic analysis of proposed backfits. In the past, in the words of Bill Dircks, there are 83 different ways backfits can be inflicted on the utilities. It is not clear that these backfits have indeed led to greater safety rather than less safety.

Mr. **Nielson**. One last question. Mr. Faden and Dr. Lidsky both have said that they are for standardization, they don't think this legislation is the way to do it. Dr. Lidsky in fact said that would stifle research and would not get us to the right point.

Mr. Jacobs and Dr. Dean, how do you feel about that? Do you believe standardization would stifle your research at all, or in any way limit our ability to get the very best design?

Mr. **Jacobs**. No, sir, any design could be developed to the point it could be standardized.

Mr. **Dean**. Mr. Nielson, no, sir. I think that with the standardization, that is a must. As to the earlier question of yours as to what should be standardized from the legislation, from the regulatory approach, I think we must recognize there are different types of systems available today or available in the future, and from a regulatory point of view, we are looking for safety related systems. Those systems, subsystems and structures that protect the public, those are the ones that we favor legislation with regard to standardization.

There are other systems that if you can prove it does not affect the safety of the public, should not be subject to legislation and standardization, but the commercial world will force that standardization.

Mr. Nielson. You don't feel the market forces would carry that standardization without legislation?

Mr. Dean. I think the market forces will be there, but I think leave it to the market, when you get away from safety related systems, leave that to the marketplace to force the standardization. In other words, one plant may require a certain system for safety related functions to be standardized. Another may not. Don't force it upon——

Mr. Nielson. What is standardization then?

Mr. Dean. My standardization is to the safety related systems, and that is defined as a system that is required to protect the public.

Mr. Nielson. Just the nuclear power supply?

Mr. Dean. In some cases, not the total nuclear system. A steam generator in one plant may be required to protect the public. It may not in another. The NRC must look at this.

Mr. Nielson. Thank you, Mr. Chairman.

Mr. Bryant. The gentleman from Florida.

Mr. Bilirakis. Thank you, Mr. Chairman. Mr. Chairman, I have a short opening statement that I would ask unanimous consent to be included in the record.

Mr. Bryant. So ordered without objection.

[The prepared statement of Mr. Bilirakis follows:]

STATEMENT OF HON. MICHAEL BILIRAKIS, A REPRESENTATIVE
IN CONGRESS FROM THE STATE OF FLORIDA

DECEMBER 10, 1985

HEARING ON NUCLEAR POWERPLANT STANDARDIZATION

I WANT TO THANK YOU, MR. CHAIRMAN, FOR TAKING THE TIME DURING THIS BUSY PERIOD OF THE YEAR TO HOLD A HEARING ON NUCLEAR POWERPLANT STANDARDIZATION.

DURING THE JULY 25 SUBCOMMITTEE HEARING ON THE PROBLEMS AFFECTING THE NUCLEAR INDUSTRY, THE WITNESSES AGREED THAT ENACTMENT OF LEGISLATION TO PROMOTE STANDARDIZATION WOULD BE AN IMPORTANT FIRST STEP TOWARD RESTORING NUCLEAR POWER AS A VIABLE OPTION FOR OUR COUNTRY'S FUTURE ENERGY NEEDS. OF THE MANY BENEFITS TO BE DERIVED FROM SUCH LEGISLATION, THE MOST IMPORTANT APPEARS TO ME TO BE THE ENHANCEMENT OF THE ALREADY IMPRESSIVE SAFETY RECORD OF NUCLEAR POWERPLANTS, PROVISION FOR EARLIER AND MORE INFORMED PUBLIC PARTICIPATION, SHORTER CONSTRUCTION TIMES, AND THE CREATION OF REGULATORY STABILITY. IN LIGHT OF THESE SIGNIFICANT BENEFITS, I URGE THE CHAIRMAN TO MOVE FORWARD ON LEGISLATIVE ACTION ON THIS MATTER.

I WELCOME THE WITNESSES INVITED TO TESTIFY BEFORE THE SUBCOMMITTEE TODAY AND I LOOK FORWARD TO HEARING YOUR VIEWS ON THE LICENSING REFORM LEGISLATION PRESENTLY PENDING BEFORE THE SUBCOMMITTEE.

Mr. Bilirakis. Based on prior hearings I thought I was pretty clear on the definition of standardization. Now I am finding out I am not clear at all.

Three bills have been introduced so far on standardization, in spite of the fact that some people have testified before this committee that legislation is not needed, that the NRC has the power now, the authority now, to require a form of standardization. According to some testimony, however, the NRC apparently is not carrying forward that authority, and this is why we talk about legislation.

Mr. Faden, you seem to be pretty set on the fact that legislation is not needed. Are you satisfied that NRC is carrying forward its authority adequately? You seem to be for standardization. Is NRC doing its job adequately to your satisfaction?

Mr. Faden. On balance, Mr. Bilirakis, I would say they are not. They could have done, over the past 10 years or even now, a lot more to encourage designs up front. They could require, as we mentioned in our prepared statement, that any applicant for a construction permit submit a complete and final plant design. That by itself would ensure standardization.

They have the regulations on the books, appendix Q, to enable to them to approve standardized designs. As Mr. Brewer mentioned, his firm and GE are having those approved at this time. That is why we don't believe that the legislation is necessary. We think this legislation has become contentious because of a lot of other issues incorporated in it, and the net effect may have been to slow down rather than speed up the standardization process.

Mr. Bilirakis. We had a hearing on the plant in Toledo, Davis Besse, a particular problem that took place there. I'm not sure what we solved in that hearing. We may have just wasted taxpayers' dollars.

In any case, in these hearings, if we determine a solution to a particular problem, it only solves that particular problem at a specific plant. Without standardization our efforts don't really do any good as far as any of the other plants are concerned. And this just doesn't make any sense to me.

I feel that standardization is critical. I feel that the nuclear power industry is not going to reach its potential unless we come to some form of standardization, which I suppose has to be tied into proper regulatory attention and reform.

The chairman, much to my surprise, used words such as "our goal is a single standardized design." I don't know how we would reach the point of a single standardized design, but that is a question I would like to ask you gentlemen if I have time afterwards.

But if we had a single standardized design and if that single standardized design, Mr. Brewer, were not 100 percent consistent with your design, with your company's design, with your custom-made design, could your company not be flexible enough to adjust to that standardized design and still remain in business as far as furnishing these reactors are concerned?

Mr. Brewer. You are suggesting a single national standard design, and, yes, Combustion Engineering could accommodate that technically. We do—we are engaged in both the engineering and the manufacturing side of the business.

But could I return to the first issue that you raised, and that is, do we need legislation to implement standardization?

Technically, the only feature of the proposed legislation that cannot be implemented without legislation is the one-stop/one-step licensing process. And as Mr. Priory has pointed out, we cannot have standardization without that, and we cannot have standardization without stabilizing the licensing process and avoiding this chronic design-as-you-go process, so the two things go hand-in-hand.

Mr. **Bilirakis**. Yes, I would agree.

Mr. **Brewer**. We have done our part in industry, and we're seeking this legislation to make sure that the Nuclear Regulatory Commission does its part.

Mr. **Bilirakis**. All right. Well, your answer, insofar as your company having the adaptability to adapt to whatever single standardized design might be, would that apply also to the other two vendors for these nuclear power plants?

Mr. **Brewer**. I can't speak to that. What you're suggesting is a monopolistic configuration for nuclear supply, and that is something which I do not feel is appropriate for our U.S. economic system.

Mr. **Bilirakis**. Let's let Dr. Dean respond, then. I see him——

Mr. **Dean**. Well, I know one company that is not flexible enough to change our design to a single standardized design light-water reactor, and I would ask that this be kept in mind, not just for the HTGR, but for other very promising nuclear alternatives. And other than electricity production, the high-temperature capability of the HTGR is the only system available for these many, many process heat applications, which today are fired solely with fossil equipment.

So when we go toward a standardization, I think—I request that the subcommittee bear in mind that there are other systems that have unique positions in our energy future that would—could be standardized, but not to a national design, because the HTGR is just totally different from these light water systems.

Mr. **Bilirakis**. What if your company had an input into whatever this standardization might turn out to be?

Mr. **Dean**. We'd have to become a light-water reactor supplier and abandon all the features, I would say, of the high-temperature reactor.

Mr. **Bilirakis**. So when we talk about standardization, we could be talking about standardization based on particular suppliers. In other words, maybe Combustion Engineering would have one standardized design, and in every instance, when they were selected to furnish the plant, it would be that one standard design, as far as their concerned. And possibly someone else would have a different standardized design and so on and so on, so we would not have a design-as-you-go type of a thing as you have now, but you still would not have real, true standardization; isn't that true?

Mr. **Brewer**. Well, standardization does not mean that there is only one choice available.

Mr. **Bilirakis**. It might not mean that there's only one choice available.

Mr. **Brewer**. There might be three. It's conceivable that Combustion Engineering—well, it is, in fact, a fact that Combustion Engineering has a standard offering, a standard plant offering. Likewise with General Electric. And when the HTGR is developed and deployed, I would urge that that be a standard design as well, and I think Mr. Dean agrees with that. Likewise with the liquid metal breeder.

Mr. **Bilirakis**. If one of your particular designs runs into some sort of a problem, the plant itself runs into some sort of a design problem, if you will, and that matter is then taken care of as a result of some sort of a design change, that would then be applicable to all of the plants that are——

Mr. **Brewer**. In my plant population.

Mr. **Bilirakis**. Yes; but it would not be of any help as far as the others are concerned.

Mr. **Brewer**. That's correct, unless the problem was so generic that all the plants of that class or that concept had the same disease or had the same problem.

Mr. **Bilirakis**. Could we have a standardized design that would cover major portions of a plant or maybe generic portions of the plant, and possibly then have individual designs in some of the other areas that are more tied into that particular company?

Mr. **Lidsky**. In direct answer to that question, I would guess likely not, because the plants are very complex and interact in very complex and sometimes unpredictable ways, and I think it's essential that within a certain envelope, that systems be totally standardized where the interactions really might have an effect on safety.

Now how big that envelope is depends on precisely the sort of technology that one is using, and some systems have very large envelopes that you have to control, and some have very much smaller ones.

I would like to respond also to a question implied, in your question.

One can—and people have advocated this, and this would lead in some sense to a degree of standardization—the setting of safety goals for a plant; if a plant meets those standardized goals, then it is an accepted plant. What one does by taking that approach is define the boundary of the public's interest, but within that boundary let all the vendors compete as best they can, to meet those goals in the best, most efficient, cheapest possible fashion.

I think almost everybody at this table agrees that some degree of standardization is a very good thing. The only question is how that standardization is achieved and where the impetus for change in systems comes from. But standardization by itself I think is an agreed-upon goal by everyone, I think, on this panel and, I suspect, everyone on the committee. It's the detail that is so important.

Mr. **Bilirakis**. I think that is what we have got to reach in these hearings, and I'm not sure that we're reaching that point here today.

Mr. **Bryant**. The gentleman's time has expired. We will get back around to this.

The gentleman from Texas, Mr. Hall.

Mr. **Hall**. I think many—and I guess Dr. Brewer, Dr. Dean, or Mr. Faden or whoever—someone mentioned and compared this with the aircraft industry. Even the aircraft industry went through some standardization. They rode the prop as long as they could and then the turboprop, and then somebody had the suggestion that maybe jet propulsion might work. They even walked away from having two wings on them, and they've done very well.

Standardization, to me—and this may not be the terminology that more educated minds would use—but it seems that it would provide a modular approach, and it seems it would have some benefit on those who would attack the design, simply to express their disdain for any type of nuclear energy.

Talk to me about the burden of proof that this bill would create and how it would shift if we set up standardization.

Is that beneficial, Dr. Dean?

Mr. **DEAN**. Well, I fully agree with you that when you consider standardization, you should be considering it in this modularized fashion. That certainly has been our total thrust here for the last over 2 years, is to come up with what we say is a modular standardized plant, factor fabricated. You are building essentially all safety-related parts in a factory with the same crew, instead of using different crews on different sites for this purpose.

So from the modular standardization, we are totally supportive of that feature, and that has been the thrust of our program.

Mr. **HALL**. I get the feeling that we have an awful lot of people that take the position, "I'm for standardization, but * * *", and it's just like these folks that are for the strategic defense initiative, but * * *, and they're really and truly just totally opposed to it, and they throw up roadblocks, and I think this, at least, would wipe away some of the roadblocks of those that want to attack the design and using the present burden-of-proof theory that would shift and change with this bill.

Mr. **DEAN**. I fully agree with that comment, sir.

Mr. **HALL**. That's one out of one, two, three, four, five, six, seven. I'm batting pretty good.

Dr. Brewer?

Mr. **BREWER**. Mr. Hall, you raised the aircraft industry a moment ago as being—as having gone through several phases of standardization.

I would point out that Boeing, Lockheed, and Douglas each have a standard widebody aircraft product at this time, and there are three designs, and each of the three designs is standardized and multiply produced and sold. And that is the sort of model I would envision in the nuclear powerplant business.

Mr. **HALL**. Doctor.

Mr. **LIDSKY**. Let me carry that one step further. Each one of those standardized designs of Lockheed and Douglas and Boeing was designed without legislative boundaries put on it. The planes were designed by the producers. There were no restrictions placed on backfit criteria. Those planes were, in fact, designed and standardized as a strict result of market forces.

Mr. **PRIORY**. Mr. Hall, we have proposed a process whereby the burden of proof would be up front with the utility that wishes to build it when it came in for design certification and when he asked for that license to build it.

Beyond that point, there would be restrictions to assure that safety items that came up after that point in time, once the license had been provided or issued, that safety issues that warrant, based on cost-benefit analysis, warranted inclusions would be included in that standard plant. Those that did not would not meet that threshold, and as a consequence, hopefully we would have a stabilized process.

That's what we've proposed.

Mr. Faden. Mr. Hall, I think you have hit the single most important issue in this legislation, which is the burden-of-proof issue after a design has been approved.

There is a case to be made for stability, but there is also such a thing as carrying it too far, and we believe that this legislation does that. It makes the burden of proof so high on the proponents of any change in a design that it makes it almost impossible, once the design has been approved, even in the face of very serious safety information, and that burden would apply not just to outside intervenors, but to the NRC staff as well.

So that, in a nutshell, is why we think this legislation goes too far in its pursuit of stability.

Mr. Hall. Mr. Faden, you have also complained that all three of the bills subsidize the nuclear industry by directing NRC to defer payment of application fees for design approvals until the design is actually needed.

Isn't that just another roadblock that contradicts the history of breakthroughs energy-wise, including hydropower? The dams were built. They didn't pay for them, those that made them available to the public, that answered an energy crisis in another day and time, at a time when it's not nearly as serious as it is today, were allowed to defer their payment until they used it, actually benefited from it.

Doesn't the benefit to the public at large cry out that that's a good incentive to these people to put their marketplace surveys and to direct their capital?

Doesn't the incentive override that complaint of yours?

Mr. Faden. I don't think so. I think the hydro case is different, because in the case of the very large dams, the Grand Coulees, you can only have one of them, and only the Federal Government was in a position to take on a project that large. Here is a——

Mr. Hall. How about the space program? We're in that right today, and the Federal Government picks up most of the tab for that, crying out for folks to come aboard to take a little of the slack up, and eventually they will, but without that incentive, would we ever develop those items in space that are so necessary medically and to achieve the other thrust of that that we're looking for in space?

Isn't that all—don't we have to have that incentive to get people to support that that the public would benefit from?

Mr. Faden. I think we've got a different situation here. We've got, as you can see looking down this table, a number of firms in competition here, looking to see who can bring out the best design. I think this is an area where market forces will protect the public, benefit the public, in a way that's much more efficient than any kind of Federal intervention, particularly when you're talking about very reduced Federal resources on energy generally.

This is a case where we think this technology ought to start paying its own way. It's had a history of being subsidized greatly up until now, which I don't think has always been to the benefit of either the public or the industry itself.

Mr. **Hall**. The need for it varies with the emergency of the moment, and the world price of oil and OPEC hijackers, and whoever else we have to depend on for energy.

Don't you think the public benefits to go from 8, 10, 12, 15, maybe to 25 percent of our energy, to encourage them with—this isn't any big deal, and I won't make a big deal out of it—but to forego the application fee for a design approval, if they are doing that in the interest of making a buck themselves of course, but in solving the energy problem?

Mr. **Faden**. As you know, the Federal budget is getting pinched pretty tightly all around, and we are talking several millions of dollars here. I think what the public benefits from most of all is fair and open competition among all forms of energy, all sources of electricity. We don't have the Federal Government in a big way participating in the development of energy conservation sources any more.

Mr. **Hall**. That can better be done, can't it? If we properly set the burden of proof to wherever Jim, John, and Joe can't stand there with a "No Nukes" sign and file suit and avail themselves of certain benefits under the Rules of Evidence?

Mr. **Faden**. We think they ought to have one fair shot at it and one fair shot only.

Mr. **Hall**. I thank you for your testimony. I yield back whatever time I haven't used.

Mr. **Bryant**. Dr. Lidsky, you testified earlier about the concept of licensing by test. I wasn't in the room. Would you mention that again briefly?

Mr. **Lidsky**. The name describes the concept. The idea is to build a full-scale prototype of the sort of reactor you would like to have licensed, whose design you would like to have certified, and to experimentally do those things you would like to have done to prove the reactor can survive any combination of events.

For example, you might reasonably expect to ask that all the coolant be removed from the reactor. You might reasonably expect to ask that the control rods not be inserted into the reactor. You might ask that the reactor in actuality demonstrate those claims that you have made for it, in order to achieve a design certification. If that test is rigorous enough—this is the stage at which the public enters to decide whether the test is rigorous enough—you have automatically gotten to a place where in fact intervention in the certified design is very much more difficult. All the things that you might postulate could have happened will have been tested. There is much less opportunity for subsequent claims that the design does not meet the design requirements.

Mr. **Bryant**. I would like to ask each of you to comment on that. Dr. Dean.

Mr. **Dean**. I think the license by test is a very novel concept. It is somewhat restrictive to certain plants. All plants just cannot be licensed by test. This HTGR in the modular version appears to have those characteristics. We currently have a study underway that is privately funded that should be completed by February where we are looking at this in great detail as to the license by test.

Is it really a viable option, can you put bounds on it so you don't just test and test forever. This, with all the HTGR program participants, not just GA, but with Bechtel and Stone & Webster, GE, and Combustion Engineering, we are participating in a study at this time to try to determine the real viability of this license by test project.

I must say at this time, it certainly could be an attractive option, and we should not foreclose it.

Mr. BRYANT. Dr. Brewer.

Mr. BREWER. Mr. Chairman, in the early days of nuclear power, there were in fact both in the Light Water Reactor Development Program of the late 1950's and early 1960's and in the Advanced Converter Reactor Development Program, certain tests resembling those that Dr. Lidsky has described.

For example, the LOFT facility in Idaho Falls. It was not a power generator admittedly. It was a model test. The system was stressed to the limit. The light water reactor concept met the test.

Mr. BRYANT. Mr. Priory.

Mr. PRIORY. Mr. Chairman, when I first asked to include my written statement into the record, I failed to do that when I initially made my presentation.

Mr. BRYANT. It will be included.

Mr. PRIORY. My feeling on that is that it is a good idea and money should be alloted, legislation should allow that to proceed. I'm speaking from an utility perspective, as looking at new generation sources in the mid-1990's.

I don't believe the concept that Dr. Lidsky has proposed here is one that could be ready for the mid-1990's, for example, because that would require the plant orders be placed in the

I think the issue before this subcommittee is the question of making a viable nuclear option available in the near term here in the United States. I would say license by test, yes, we should proceed. It's a good development effort. I think it should be funded and nothing should be done in the legislation to prevent that from proceeding on.

I do not think that is the key issue here today at all. I believe it is making a viable nuclear option available to this country, such that we can use it.

Mr. BRYANT. Mr. Jacobs?

Mr. JACOBS. Mr. Bryant, I believe that license by test should be one of the options available to obtain licensing of a design.

Mr. BRYANT. Mr. Faden?

Mr. FADEN. I think license by test is something that we should take a very serious look at. As Professor Lidsky indicated, it will only work with small modular reactors. Since those kind of reactors have a lot to commend them, perhaps the whole process should be given a little push in that direction.

Mr. BRYANT. Mr. Brewer, in your prepared testimony, you remarked that while a high level of standardization for safety related systems is desirable, a lower level of standardization is without consequence for the remainder of the plant.

From a regulatory perspective, do you lose many of the benefits of standardization if you adopt the owner approach? In other words, how much better off would you be if the NRC is still in the position of having to worry about a large number of different possible interactions between the nuclear side of the plant and the less standardized nonnuclear balance of plant?

Mr. **Brewer**. What I said in the testimony, Mr. Chairman, was the nuclear steam supply system is the heart of the safety concern of the Nuclear Regulatory Commission, and their absolute and total design details should be available including supporting analysis and documentation. On the balance of plant, which is Mr. Jacobs' concern, many of the systems in the balance of plant are not safety related and therefore, need not have that degree of design detail submitted to NRC for their review. It is not relevant to the NRC review.

Mr. **Priory**. I might add that we have proposed a process whereby that information would be available, but perhaps not submitted to the NRC unless required to make their requisite safety determinations. Our proposal includes balance-of-plant details, construction drawings and what have you, in addition to the nuclear island, to be made available.

Mr. **Bryant**. Anyone else who would like to comment on that? [No response.]

Mr. **Bryant**. I would like to ask you if you think we should continue to rely on the single failure criterion or should we consider the four independent safety train approach followed by some of the European programs?

Mr. **Dean**. Mr. Chairman, we addressed that in our responses. Basically you have to look at the entire plant and the common mode failures. We talk about single failure criteria and adding more trains. The adding of four trains here may not provide this added assurance when you look at the common mode failures that could wipe out all four of those trains. I think we have to look at the single failure criterion but more importantly, we have to tie it with common mode failures and do the probalistic risk assessment of the entire plant before you can say which is the better way.

Mr. **Bryant**. Thank you. Dr. Brewer?

Mr. **Brewer**. I believe, Mr. Chairman, that the NRC requirement that we now—the criterion that we are now operating under has been quite satisfactory and need not be changed.

Mr. **Bryant**. Thank you. Dr. Lidsky?

Mr. **Lidsky**. Here I think we see an example of the danger of the legislative process getting deeply involved in the whole question of safety and licensing. The question makes little sense when applied to the sort of plant which doesn't require those particular safety trains to achieve its safety goals.

I would like to point out that is definitely a light water reactor related question. Most of the legislation that has been proposed is directly aimed at the LWR.

My main fear is that in concentrating too much on that, we put quite substantial roadblocks in the path of systems better suited than the LWR coming along in the future. That sort of thing has happened. It has happened in the NRC regulations, without thought as to what other sort of reactor might come along. Quite specific regulations were put in place. We have been trying now for the last 2, 3, 4 years to back away from the specific regulations or to make them better fit other reactor types.

Mr. **Bryant**. Mr. Priory?

Mr. **Priory**. Mr. Chairman, I think we have had good experience with single failure criterion in the industry. We have over 1,000 reactor years domestic experience in the light water reactor area, and overseas we have far more reactors with basically U.S. technology over there. We have had good experience with those.

I would also add to Dr. Dean's testimony that common mode failures are our concern, with four independent safety trains. Likewise, I would say from the operator's standpoint that the complexity of the plant is also a question when you begin to introduce two times perhaps more pieces of equipment than there had been previously.

I think those are things that need to be studied. I don't think in any way this legislation should be tied to that kind of safety review and study. I think the technology that we have presently is a proven technology. It is a mature industry in terms of the technology. Single failure criterion is very much a part of that technology.

Mr. **Bryant**. Thank you.

Mr. **Jacobs**. There is nothing I can add to what has just been said.

Mr. **Faden**. I would only add we echo Dr. Lidsky's concern that this question is restricted to light water reactors. We think more independent trains would significantly improve the level of safety, among other reasons, by making the components—enable the components to be smaller and thus use more off-the-shelf components. We would emphasize we don't see that NRC is always enforcing the single failure criterion at this point.

Mr. **Bryant**. I am in the same category that I think Mr. Bilirakis placed himself in earlier, with regard to puzzlement about what standardization means to everybody. I have the feeling that it still means different things to different people.

I wonder if it would be productive if we just went down the row and asked you to give a one or two sentence statement as to what it means to you? Dr. Dean?

Mr. **Dean**. From the regulatory point of view, we believe that all safety related systems, subsystems and structures, and those are the ones that are required to protect the public during accident conditions, all those systems are what we favor being standardized in this regulatory process. Once that system or subsystem is accepted as standardized, we know we can use it for its function in subsequent plants.

I think different technologies and even the same technology with different vendors, there may be some systems or subsystems that would be standardized, from a regulatory point of view, and not in the other vendor's design.

It is the safety related, to protect the public, all those that you like to see standardized from the regulatory point of view.

Mr. **Bryant**. Dr. Brewer?

Mr. **Brewer**. I would define a standard plant as a plant that can be reproduced essentially unchanged from site to site, from utility to utility, and meet all of the standards. A preapproved standard plant is a plant which has regulatory approval for its operation before construction commences. The design standing behind that application for the nuclear steam supply system and other safety related equipment, should be essentially complete.

Mr. **Bryant**. Thank you. Dr. Lidsky?

Mr. **Lidsky**. It is a difficult question. I would define it as a standardized system, that has specific regulatory approval for application. But a standardized system might vary from something as small as the nuclear steam supply system by itself to the whole plant, to the details of the diesels. In each case, it depends in fact on what, for that particular system, the safety envelope was.

Mr. **Bryant**. Mr. Priory?

Mr. **Priory**. I define it as preapproval of an essentially complete design prior to construction, and that design would be based on a mature technology, which I think is necessary for standardization. It would also require regulatory stability to ensure that standardized plant remains standard, because I think in the absence of that regulatory stability, despite the fact that we might agree one day on what a standard plant is, I think the ones thereafter that may well have changed. I believe we have to have that in the standardization provision.

Mr. **Jacobs**. A standardized design is one intended for use many times at many site locations. That is the type of design that we described in our license application and received three approvals on. That type of design cannot remain standard unless the regulatory requirements are stabilized and unless an effective change control system is put into place.

Mr. **Bryant**. Mr. Faden?

Mr. **Faden**. We think a standardized design is a complete final design that at a given point in time is good enough to be used at more than one site. We don't think the concept implies freezing in a design for long periods of time.

Mr. **Bryant**. I have run way over. I recognize the gentleman from Florida for any additional questions.

Mr. **Bilirakis**. Dr. Lidsky, could you arrive at this envelope, as you call it, whether it be limited strictly to safety related items or include additional—the generic standardized design, if you will? Could you as an individual do this? I'm not saying whatever you come up with would be acceptable in the industry by everybody, but could you do this?

Mr. **Lidsky**. I believe I could. I believe for different plants, I could draw very different sort of envelopes. I rather suspect in similar cases, there would be a fair degree of unanimity on where one chose the boundaries. The question then is whether, in fact, the plant within those boundaries does meet the requirements you put on it. That is where the judgment comes in. As to where the boundary lies, I think there is a certain unanimity there.

Mr. **Bilirakis**. You say for different plants. I am talking about one standardized boundary.

Mr. **Lidsky**. For different plants using the same technology, the boundary is approximately the same. I suspect the Combustion Engineering reactor and a Westinghouse reactor and a GE reactor, even crossing boundaries slightly of technologies within light water reactor, would have approximately the same boundaries, but reactors of other sorts would have very different sort of boundaries.

I keep coming back to the issue that I came here to raise, and that is distinctly different technologies. Legislation too narrowly drawn will act to the benefit of one against the others. Very likely, if the legislation is intended to improve the lot of the technology that is in existence now, it will put boundaries in the way of changes, and those changes might very well be beneficial.

Mr. BILIRAKIS. Do we not now have a situation where you run into design problems, change of design as far as one particular plant is concerned, but that change of design is not in any way at all helpful as far as the other plants go?

Mr. LIDSKY. Absolutely so.

Mr. BILIRAKIS. That's bad.

Mr. LIDSKY. It is. One of the comments I made in my written statement, where I did have room to ramble on at great length, was that the light water reactor is an exceedingly complex system. We are trying to legislate it through an exceedingly complex institutional system, and that leads to exactly the sort of effects that you are describing. Because it is so complex, different people will optimize it in very different sorts of ways. Because it is so complex, people will judge whether it meets its design goals as positive or negative.

A point I would like to raise is the light water reactor is not very well suited to our institutions. We can improve our institutions to some extent and that will improve the viability of and our ability to use the light water reactor. I want to make sure that is not the only thing we do. We need sufficient room for the technology to change also.

Mr. BILIRAKIS. Of course. I think we should always be concerned with the advancements in the state of the art. I guess it goes back to the statement one of you made earlier.

Mr. Priory, you made the comment that it would take approximately $200 million to effect a standardized design, or words to that effect?

Mr. PRIORY. Yes, sir. That's the estimate we made.

Mr. BILIRAKIS. Where in the world would all that money be spent?

Mr. PRIORY. All that money would be spent on upfront design engineering, development of construction drawings, and finalization of the details prior to submittal for the application; a substantial piece of work.

Mr. BILIRAKIS. Who would be spending this money?

Mr. PRIORY. If I were to get out my crystal ball to take a guess at who might spend that money, I think the only likelihood for that occurring, in my opinion, is a consortium of utilities getting together. To be able to put up that kind of money up front, one has to have some investors to tag along as well, as you know. At this point in time, the nuclear option does not look very favorable.

It would be a matter of passing legislation that would reduce the risk, certainly the perceived risk, and those utilities getting together in a consortium and perhaps competitively bidding the standard NSSS for that consortium, which may be one of the many vendors, the two or three vendors that are available at this point in time, and there would only be two vendors for a PWR, selecting one of those and rolling that into a standardized design, investing $200 million and arriving at the NRC with a request for a standard design certification or a construction and operating license.

I don't think you will see many consortiums frankly getting together in nuclear power at this point in time and trying to put together $200 million to do what I just described. I think you will see very, very few of those.

Mr. **Bilirakis**. Thank you.

Mr. **Bryant**. I'd like to thank all the panelists for being here today. I don't believe there are any more questions, in which case, we will call the meeting adjourned.

[Whereupon, at 1:35 p.m., the subcommittee recessed to reconvene at the call of the Chair.]

[The following material was submitted for inclusion in the printed record:]

STATEMENT BY COMMISSIONER JAMES K. ASSELSTINE
UNITED STATES NUCLEAR REGULATORY COMMISSION

BEFORE THE

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

CONCERNING NRC'S ACTIVITIES ON
ADVANCED REACTORS

OCTOBER 31, 1985

Madam Chairman, I would like to add a few comments on the Commission's proposed Advanced Reactor Policy Statement. As it is developing, it appears that the Commission's advanced reactor policy statement will encourage, but not require, safety improvements in advanced reactor designs, and will express a willingness on NRC's part to conduct safety reviews of advanced reactor design concepts so that NRC will be in a position to act on any future plant or design license application. I support these ideas as far as they go. However, I believe that more is needed to articulate an effective regulatory policy and to ensure a successful program for future nuclear powerplants in this country, whether those plants are of a type similar to current LWR's or whether they are of more fundamentally different design. In particular, such a policy should reconsider the Commission's regulatory practices of the past thirty years. Those past practices can be characterized as primarily a reactive regulatory regime to what the designers propose. It leaves resolution of issues to what one industry executive called the rough, tough, surly competitive elements. Safety systems are limited because of cost considerations.

Containment capabilities are minimized to reduce costs. Core power densities have been driven to the limits of materials capabilities and our understanding of decay heat removal phenomena. And the balance of plant is designed to lower standards than the reactor systems to minimize costs. These competitive forces are what lead to the level of safety achieved in the current generation of nuclear power plants and are in part responsible for the poor performance of some of our plants.

The NRC and AEC before it have often avoided developing stringent specifications or design requirements because of a fear that, if the Commission were to be too specific in its requirements, the emerging industry might be slowed in its growth and innovation might be discouraged. That argument might have had some validity in the 1960's and 1970's when the current generation of reactors was being designed without the benefit of significant operating experience or data. However, now that we have considerable worldwide experience with a large variety of nuclear reactor designs, I believe it is time for NRC to become more proactive in what it will require of future generations of reactors.

Following the TMI-2 accident, the notion of a demarcation between the current generation of plants and a future generation of plants was raised, with the distinction that the latter would be designed based on a reformulation of the Siting Criteria and General Design Criteria to reflect all that had been learned over the years, including broader lessons from TMI-2. Thus, the TMI Action Plan was developed with the current generation of plants in mind, leaving open the question of possible broader changes for a future generation of plants. One such broad change could be abandonment of the so-called Single Failure Criterion which experience shows may not be serving us well. The June 9, 1985 accident at Davis Besse is a case in point where 14 separate failures occurred.

Many foreign countries are requiring four independent trains of safety systems whereas NRC requires only two. When NRC reviews advanced designs such as the one being jointly developed by a U.S. vendor and a foreign country, the NRC staff does not accept as prudent additional safety features being required by the foreign country. Rather, Commission practices and procedures require a cost-benefit analysis to justify any additional safety feature. This analysis is typically incomplete and often crude. Furthermore, the Commission gives little consideration to the enormous uncertainties in reactor risks in its decisionmaking process. In my view, this approach to reactor safety needs improvement. In my view, there has been insufficient thought and effort in developing a map for the future. The Advanced Reactor Policy Statement provides no guidance on what containment capabilities will be required; on whether the single failure criterion is adequate for the future; on acceptable core power densities, an issue which has a significant bearing on the core meltdown risks to the public; and on the root causes of the core meltdown risks that might be designed out of the future generation of reactors. Nor is there guidance on what standards the balance of plant must meet. I would have expected that NRC would have approached a future generation of nuclear powerplants with an attitude of correcting these past weaknesses. The proposed Advanced Reactor Policy Statement does not reflect that kind of attitude.

Developed countries abroad appear to be designing, constructing, operating and maintaining better nuclear power plants than those of this country. Foreign countries are demanding more safety and reliability in their current generation of plants than the NRC is requiring of the U.S. plants. Yet, this Advanced Reactor Policy Statement would accept the next generation of U.S. power plants if such a design provides a level of safety equivalent to that achieved in the U.S. designs that were completed over 10 years ago. I do not think such a policy serves the country well. My concern is not merely that we should keep up with others. Rather, my concern is that the current generation of plants is still surprising us in their performance. There remain great uncertainties in the level of risk they pose to the public. In such cases, I believe prudent decisionmaking would come down on the side of improved safety, not only for the current generation of plants but for the next generation as well.

If there is to be a future generation of nuclear power plants and if the nuclear option is to be an important element of the nation's future energy mix, then we -- the NRC, the vendors, the utilities, and the Congress -- must ensure that the next generation of power plants is substantially better than the current generation. The next generation of plants must be more reliable, more forgiving, simpler, easier to construct, easier to operate, and easier to maintain than the current generation. Any design that does not accomplish this is not acceptable in my view. I say this for a straightforward reason. We cannot afford to will to the future reactor designs that have a 50% chance of a core meltdown every ten to twenty years in a population of 100 reactors. We should not will to the future the great uncertainties in safety levels that exist today. Nor should we will to the future consumer reactor designs that have a 50 to 60 percent capacity factor.

We must step back and examine the strengths and weaknesses of past and current designs and the approaches taken in getting where we are today. Only then, in my view can we intelligently map a course for the future. I am encouraged that there is a segment within the industry that is undertaking a fresh look at the nuclear technology. The forward-looking members of the industry are attempting to generate a set of requirements that, from the standpoint of the utilities, must be met before utilities will consider placing new orders. I find it disappointing that the NRC cannot generate a set of safety requirements for the next generation of power plants.

However this policy statement comes out, I believe the message should be that: (1) future reactors should have a higher margin of safety than the current generation; (2) the regulatory regime will be tailored to the demonstrated risk of the design; and. (3) the Commission should encourage submittals of the PIUS and the HTGR designs for staff review. In the last analysis, however, the factor that will have the greatest effect on whether there will be advanced reactors is the performance of the current generation of reactors. I believe that it would be useful if Congress would mandate that NRC: determine the root causes of the nuclear power plant risks to the public, develop a set of requirements that would minimize those root causes in a future generation of plants and assess alternatives that might lower those risks in the current generation of plants. Thank you.

COMBUSTION ENGINEERING

Shelby T. Brewer
Senior Vice President
Nuclear Power Systems

December 6, 1985

The Honorable Edward J. Markey
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Markey:

Thank you for your November 26, 1985 letter inviting me to testify at the Subcommittee on Energy Conservation and Power Hearing on Nuclear Power Plant Standardization on December 10, 1985. Combustion Engineering is extremely interested in licensing reform and I am looking forward to sharing our experiences and thoughts with you.

Your letter also posed a series of preparatory questions. Attached please find our responses.

Respectfully,

Shelby T. Brewer

STB:ss
Attachment

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Question 1

How should the term "standardized design" be defined? How detailed a design should be required for a standardized plant design approval? Please be specific.

Response

A standard plant is a plant (or major system) that can be reproduced -- essentially unchanged -- from site to site, utility to utility, and meet all standards.

A preapproved standard plant is a plant which has regulatory approval for its operation before construction commences. The design should have sufficient detail available so as to provide all of the information that the NRC needs to complete its safety review. For the nuclear portion, this means that the safety design work must be essentially complete. For the Balance-of-Plant (BOP), which contains much equipment that is not safety related, the overall design detail provided in the combined Construction/Operating License (COL) application could be considerably less.

Question 2

What should be the scope of standardization? Should standardization be based upon complete plant designs or should it be based upon subsystems such as the nuclear steam supply system ("NSSS") or the balance of plant ("BOP")? What would be the regulatory advantage of standardization based on subsystems in view of the large number of possible combinations of subsystems? Wouldn't the number of possible variations defeat the purposes of standardization?

Response

Each of the proposed bills before the Committee would authorize issuance of a combined Construction/Operating License (COL) only when all of the necessary information (nuclear plus balance-of-plant plus site) has been received, reviewed and approved by the NRC. No license will issue if any information necessary to complete a safety review is unavailable in any of these areas. What seems to be in question, therefore, is the size and shape of the packages in which the NRC gathers and pre-approves that information.

In order to benefit, to the maximum extent possible, from favorable foreign experience with standardization -- and yet retain the advantages and improvements that come with a competitive economy -- some flexibility in the non-safety related portions of the design should be maintained. Since the nuclear portion of the plant generates and contains the radioactive material, it rightfully commands the most regulatory attention. As a result, the nuclear scope needs to be the most standardized. Its pre-approval is, therefore, key to closing out each significant safety issue. The process we envision for standardized plants would allow for "certification" and "banking" of nuclear and balance-of-plant designs, as well as sites.

The NRC would not issue a COL, of course, until a whole plant had been presented for its approval. Use of a certified (or pre-approved) system or site would simply eliminate the need for agency re-review. The COL would become the final agency action.

Considering the very large up-front investment which is required to generate the design details necessary to support a pre-approval, and considering the potential market, I do not forsee an overly large number of possible combinations emerging. To illustrate, C-E has expended well over $100 million dollars on our System 80 design to bring it to the Final Design Approval stage. My concern, therefore, is not with a plethora of designs, but a paucity.

Question 3

The three principal vendors in the United States -- Combustion Engineering, General Electric, and Westinghouse -- produce somewhat different versions of the nuclear portion of a plant, i.e., nuclear steam supply system, nuclear island, and nuclear power block. Would standardization be affected by the differences in approach between the three principal domestic vendors?

Response

No. Although the NSSS vendors may offer slightly different scopes of supply, each of their designs must be mated with a BOP and site to form a "whole" plant. The only difference in each case will be the location of "interfaces". The end result will be the same.

Question 4

How would standardized subsystems be matched up? How would site specific factors, such as seismic design, be taken into consideration?

Response

The "matching-up" of sub-systems (standardized or custom) has already been successfully addressed by utilizing a formal system known as "Interface Requirements". This is a system where the designer specifies the requirements necessary to assure that his system performs as designed. A listing is thus developed against which the matching design can be checked.

Interface requirements have always existed. Pre-approved standardized designs have, however, exposed the process to regulatory review for the first time. The use of pre-approved standardized designs, with their engineered, reviewed and approved interfaces, should improve overall plant safety and performance.

Site-specific factors can be handled most easily by making conservative assumptions of the site characteristics that would envelope all plant sites where the design might be used. This is the way we successfully resolved the issue for our System 80 design.

Question 5

Under the standardization approaches currently being considered, could a standardized subsystem be matched up with a customized subsystem? If so, wouldn't this defeat the purposes of standardization?

Response

A standard design can be matched with a custom design. The most likely application of this approach would be to combine a custom designed BOP with a standardized nuclear system. In fact, that is the approach which was successfully utilized at Palo Verde and will be used at WNP-3. Such an approach does lessen the benefits of standardization, but only to a minor degree, since the bulk of safety issues are resolved within the standardized nuclear system.

Question 6

The legislation pending before Congress contains provisions dealing with both standardization and the combined construction permit and operating license based upon NRC's approval of an essentially complete plant design. Are these provisions interdependent or could standardization and the combined construction permit and operating license be implemented separately? Is legislation needed to accomplish both of these changes or could they be implemented by the NRC under its existing authority?

Response

Standardization and combined Construction/Operating Licenses (COL)s can, in theory, be implemented independently. If COLs were used without standardization, each utility would, of course, face very high front end design costs. With sufficient investment, however, there is no reason why a custom plant COL could not, or should not, be granted. On the other hand, if standardization is attempted without the combined COL, then the uncertainty during construction and the re-licensing during the Operating License phase would virtually destroy the opportunity for success. (See also Response to Question 15.)

It is my opinion that the NRC can indeed implement most, if not all, of the standardization provisions on its own. It is unlikely, however, that U.S. utilities would commit the massive funds necessary to begin another nuclear construction program based upon an NRC policy that could change at any time depending on an unknown future majority of Commissioners. The viability of the nuclear option may very well hinge on the provision of a combined Construction/Operating License.

Question 7

Should standardized designs be based on existing plant designs or should more advanced designs serve as the basis for standardization?

Response

The nuclear plants that are coming on-line today are based on a technology that has been developed and refined over the last 30+ years. The American public would not be well served by abandoning this vast wealth of design information and operating experience (both good and bad) available upon which to build.

I suggest, rather, that two independent paths be provided to the future. The first is an "improved" nuclear plant design based on improvements to the best that we have available today. These "improved" designs — including the "lessons learned" from Three-Mile Island and technical resolution of all applicable NRC Unresolved Safety Issues — can provide the basis for a viable standardized nuclear option in the near and mid-term. For the mid-to-long term, more "advanced" nuclear plant concepts can emerge to take their place as standardized nuclear power plants. The paths I have outined are clearly not mutually exclusive and both will benefit from the proposed bills.

In your consideration of these bills, however, I urge you not to let "the best be the enemy of the good" but rather let the criteria remain that nuclear power plants may be deployed if they provide reasonable assurance: (1) that the activities authorized can be conducted without endangering the health and safety of the public, and (2) the issuance of the license will not be inimical to the common defense and security.

Question 8

What are the lessons to be learned from the current generation of plants? To what extent should safety and efficiency improvements be required for the next generation of plants? What unresolved safety issues, should be resolved before the next generation designs are approved?

Response

See Response to Question 7.

Question 9

In connection with standardized designs, what should be the scope of "safety related" equipment and of non-safety related equipment? What standards should "safety related" equipment be required to meet?

Response

See Response to Question 2.

Question 10

In connection with standardized designs, should the NRC continue to adhere to the single failure criterion or should the NRC adopt the practice followed in a number of successful foreign nuclear programs of requiring four independent safety trains?

Response

Both the single failure criterion, which assures that safety systems have redundancy (i.e., one train serving as backup to another) and the requirement for diverse systems (i.e., a backup system based upon a different design) establish a high level of plant safety. It is not clear, therefore, that a four-train 50% capacity system would be significantly better than a two-train 100% capacity system.

Question 11

In connection with standardization, should there be any change in what equipment is required to be inside the containment building?

Response

No. Current designs already include many safety systems within the containment. Those safety systems outside containment are normally located so as to allow maintenance and/or repair while the containment is completely isolated.

Question 12

Once a standardized design has been approved by the NRC, under what circumstances should modification of that design, whether by the NRC or by the licensee, be permitted?

Response

As technology changes after a standardized plant is approved, I believe that -- absent a significant safety issue -- the changes are best folded into well engineered model revisions. There is no need for legislative or regulatory mandated change since, as technology advances, competitive pressures will suffice to bring revisions about at reasonable intervals.

When safety concerns arise -- as I am sure they will --they should be evaluated as potential backfits utilizing the "lead unit" concept. If there is a demonstrated need to change any standard plant, there is a need to change them all. Conversely, however, if there is no need to change the first unit, there is no need to change any of that model or class. Clearly to do otherwise would defeat standardization.

Following the guidelines outlined above will accrue several additional benefits. The engineering of upgrades -- as opposed to the current patch-and-fix -- will improve availability and reliability (to the benefit of the ratepayer) and thus improve safety (to the benefit of the general public). Safety will be improved not only by the better engineering of safety systems, but by the reduction in challenges to those safety systems.

Question 13

What work has already been done on standardized plant designs? Is that work relevant today?

Response

The nuclear industry and the NRC began a standardization program in the 1970's. Despite the wave of plant cancellations that began in 1978 two standard designs (CESSAR and GESSAR) proceeded through the review process and received final design approval from the NRC. A third standard design (RESAR-90) is presently undergoing a preliminary review by the NRC.

The crowning achievement of standardization to date is the issuance of a full-power operating license to Palo Verde Unit 1 on the basis of its referencing the Final Design Approval of CESSAR. Palo Verde Unit 2 may also have an operating license on the same basis by the time your hearing commences on December 10. It is identical to Unit 1. Another identical plant, Palo Verde Unit 3 will join them soon. Washinton Public Power Supply System is making plans which could lead to the resumption of construction activities at Satsop (WNP-3). If that plant is completed, its nuclear portion will be identical to Palo Verde 1, 2, and 3 because it also references CESSAR's FDA. Had they not been cancelled for other reasons, at least seventeen nuclear plants located on six different sites would be operating or approaching construction completion - all with identical nuclear portions which would have been licensed on the basis of the CESSAR Final Design Approval.

That work is indeed relevant today. It is the most substantial basis for proceeding with standardization because it is existing proof that standardization and pre-approved licensing can work.

Question 14

For how long should a standardized design approval be effective? Please provide the underlying technical reasons for this time period.

Response

The most technically supportable response to your question is that design approval should be effective for a specified number of units -- such as 50 to 100 units -- and not for a specified period of time. The reason is the overall risk from a class of plants is the product of the risk from a single plant times the number of plants. It is not based on the time period in which they were licensed. Recognizing the political impracticality of an open ended approval, however, a minimum initial period of 10 years is absolutely required. In further support of the 10 year minimum approval period, the following information is provided.

- Nuclear power has been producing electricity in the United States for over 25 years. During the first period of the industry, the designs of nuclear plants were changing rapidly. Presently, the industry has matured to a state where the designs have stabilized and few changes are being made to the basic design. Thus, 10 years is not unreasonable from this perspective.
- The NRC retains the authority and responsibility to require, at any time, a modification to a design if and when a significant safety concern is demonstrated.
- The industry will have to invest significant resources to acquire pre-approved standard designs. Having less than a ten year window to amortize their costs will provide insufficient motivation to deploy standardized designs.
- Ordering of electrical generating facilities tends to run in long cycles; ten years would prove to be a minimum window to that cycle.

- Nuclear power plants currently take 10+ years to construct. Under Standardization and Licensing Reform legislation, nuclear power plant contruction time should be condensed significantly. Even with reduced construction schedules, however, a ten year approval period is necessary to allow the incorporation of improvements on the next generation of plants to be based on actual operating experience.

Question 15

Much has been said about the need for all parties to the nuclear power plant licensing process to exercise strict discipline. Please describe how such descipline was not exercised in the past by vendors, architect-engineers, constructors, and regulators. Please also describe the discipline which must be exercised by these parties in the future. What should be done legislatively to ensure this discipline?

Response

During the early years of commercial nuclear power development nuclear plant designs were continually changing as the technology rapidly advanced and power levels increased. In 1973, the NRC halted the race to increased power levels by establishing a cap at 3800 MW(t).

Utilities and NSSS/BOP designers also indulged themselves in post-CP modifications for a very practical reason -- the design was not completed at the CP stage. Even if the design was substantially complete prior to construction, there was no means to prevent the regulators from changing the safety design criteria and guidelines and requiring the owners to backfit design changes into the plant. Without regulatory stability there was no incentive for design stability on the utility/contractor side.

When the NRC issued its standardization policy in 1978, we at Combustion Engineering recognized the benefits which could be achieved. We developed a philosophy within our engineering groups that "If it is not necessary to change, it is necessary not to change." We really did implement that standard.

The regulators had no similar compulsion, because they do not have the financial incentives which motivate the industry to maintain the principles of standardization. That is why we feel legislation is necessary to assure that the regulators are also required to observe the principles of standardization. What must be done legislatively is to adopt the provisions of the Broyhill or DOE bills.

GA TECHNOLOGIES INC. ANSWERS TO QUESTIONS

FROM

THE ENERGY CONSERVATION AND POWER SUBCOMMITTEE

ON NUCLEAR POWER PLANT STANDARDIZATION

DECEMBER 10, 1985

Questions for Energy Conservation and Power Subcommittee Hearing on Nuclear Power Plant Standardization

December 5, 1985

(1) How should the term "standardized design" be defined? How detailed a design should be required for a standardized plant design approval? Please specific.

The term "standardized design" can be defined as an adopted design for a nuclear power plant, or portion thereof, that can be replicated in multiple plant with the ability to satisfy specified functional requirements. A standard design needs to be sufficiently detailed, with its safety-related features sufficiently demonstrated, to permit qualification as a Certified Standard Design. The Code of Federal Regulations, Title 10, Part 50 (10CFR5 Appendix O, defines current rules for regulatory certification.

The level of detail design required for approval of a standardized design should be that normally required for final design approval. This level of detail is also required in order to perform the safety analyses that define risk to which the plant can expose the public. The level of detail of a safety-related subsystem would include all data required for the NRC to asse its ability to meet its prescribed functions and requirements. This could require test data on the subsystem involved as well as design calculations.

(2) What should be the scope of standardization? Should standardization be based upon complete plant designs or should it be based upon subsystems such the nuclear steam supply system ("NSSS") or the balance of plant ("BOP")? W would be the regulatory advantage of standardization based on subsystems in view of the large number of possible combinations of subsystems? Wouldn't th number of possible variations defeat the purposes of standardization?

The scope of standardization should be broken into two major areas: Regulator Standardization and Non-Regulatory Standardization.

The scope of Regulatory Standardization should be limited to only those subsystems that protect the health and safety of the public from consequences of accidents. This includes only safety-related subsystems and associated structures required to meet 10CFR100 dose limits. It would also involve assurance through analysis backed up by adequate testing that these subsystems and structures can perform the plant's safety functions. The advantage of Regulatory Standardization of safety related subsystems would lie in the ability to use such subsystems in a new plant as a "standard part" where its design details and performance characteristics have already been established. Only new, or modified, safety-related subsystems and the way they subsystems and structures would require Regulatory scrutiny for approval as a new standard model, thus reducing the Regulatory review effort.

The limiting of regulatory involvement to safety grade subsystems will put pressure on the industry to simplify and reduce the number of such systems in a plant. Since the overall plant safety level will still have to be met, such simplification and reduction in subsystems (less to go wrong) will enhance safety margins.

For a modular High Temperature Gas-Cooled Reactor the minimum scope of a standardized design would include the Reactor System (fuel and internals), Reactor Vessel System, Control System and Cavity Cooling System and supporting Seismic Category I structures.

The scope of the Non-Regulatory Standardization would include most non-safety realated subsystems and associated structures and the integration of these subsystems to satisfy the total plant's function of generating reliable economical energy. These non-safety related subsystems and related plant configurations would not be controlled by Regulatory Standardization as they do not impact the safety and health of the public.

The benefits of Non-Regulatory Standardization control can be equally significant. The industry has first-hand knowledge of the pitfalls of one-of-a-kind designs for plants and possible variations will be held to a minimum since the cost of multiple designs is formidable. Modularized - skid mounted - factory fabricated packages, minimum field construction, and replication are the standards accepted today by all vendors. Competitive standardization, as used in other product lines, is a must for the nuclear industry.

(3) The three principal vendors in the United States — Combustion Engineering, General Electric, and Westinghouse — produce somewhat different versions of the nuclear portion of a plant, i.e., nuclear steam supply system, nuclear island, and nuclear power block. Would standardization be affected by the differences in approach between the three principal domestic vendors?

Since GA has not been directly associated with LWR plant design and construction in the past, we do not have a basis upon which to adequately comment.

(4) How would standardized subsystems be matched up? How would site specific factors, such as seismic design, be taken into consideration?

Standardized subsystems must have clearly defined interfaces with, and be compatible with, other subsystems as well as their environment (including seismic). In order for standardized subsystems to be used in multiple plants at different sites, the design requirements must envelope the potential sites expected.

If a single design proves to be non-competitive at low seismic sites, the vendor has the choice of developing a different standardized subsystem for a more limited number of sites. This does not destroy the benefits of standardization if shown to be cost effective in a competitive environment.

(5) Under the standardization approaches currently being considered, could a standardized subsystem be matched up with a customized subsystem? If so, wouldn't this defeat the purposes of standardization?

A necessary characteristic of a standardized subsystem is clearly defined interfaces with matching and subsystems and structures. The balance of plant design for all sites requires a degree of customization to suit the site conditions and utility needs. It is only necessary that the design of a customized subsystem or structure meet the interface criteria established for the standardized subsystems, and structures with which it matches.

(6) The legislation pending before Congress contains provisions dealing with both standardization and the combined construction permit and operating license based upon NRC's approval of an essentially complete plant design. Are these provisions interdependent or could standardization and the combined construction permit and operating license be implemented separately? Is legislation needed to accomplish both of these changes or could they be implemented by the NRC under its existing authority?

The provisions of the legislation dealing with standardization relate to a design that is intended to be built and operated more than a few times.

The combined review and subsequent approval for construction permit and operating license could be performed if only one plant were to be built. The need for legislation to accomplish both changes is not necessary. However, one-step licensing would be an incentive that would drive the vendors towards standardization.

7) Should standardized designs be based on existing plant designs or should more advanced designs serve as the basis for standardization?

Both approaches are required. Full advantage of plant experience should be used in supporting a standard design. In fact, standardization is strongly impacted by the knowledge and experience of a successful design. On the other hand, advancements in technology, plant safety, cost improvements, etc. are not possible unless advanced concepts are allowed to establish a basis for new standardized designs. The only difference may be found in the degree of performance verification that is applied to monitor the advanced designs until sufficient operational history is available. Standardized designs that incoproate passive subsystems will have fewer uncertainties and less need for long term experience before being accepted.

(8) What are the lessons to be learned from the current generation of plants? To what extent should safety and efficiency improvements be required for the

next generation of plants? What safety issues, whether or not officially characterized as unresolved safety issues, should be resolved before the next generation designs are approved?

The current generation of plants with its highly varied balance-of-plant designs has shown the difficulty of managing and regulating such a diverse collection of sophisticated plant designs. Standardization would improve management, operation and regulation, as well as communication between licensees and regulators.

The current generation of plants was developed in an atmosphere of regulatory instability caused by a lack of well-defined (from a design standpoint) regulatory requirements at their conception. With time, and with increased public pressure, regulatory requirements were definitized in a way often in conflict with features of plants well along in the construction process. This created unresolved safety issues.

The best way to improve the economics and safety of the next generation of plants is to achieve a stabilization of the regulatory process. This can be done through the use of top level regulatory criteria that specify acceptable risk to te public. The applicant would need to show that his design met the top level criteria for compliance as opposed to negotiating design details with the regulator on a detail-by-detail basis. It is clear that this process would be further enhanced by completing the safety review before construction is initiated. Standardized designs, along with combined construction permit and operating license, would make this possible.

(9) In connection with standardized designs, what should be the scope of "safety related" equipment and of non-safety related equipment? What standards should "safety related" equipment be required to meet?

In a standardization design, the "safety-related" equipment should include any structure, system, or component that is required to meet top level regulatory criteria for protection of the public, i.e., the offsite doses specified in 10CFR, Part 100. The spectrum of accidents examined for compliance with the top level regulatory criteria must be broad, comprehensive, and complete. For example, to show compliance with 10CFR100 doses, accidents with mean frequencies greater than once in ten thousand years should be evaluated systematically and might include events with one or more independent failures, with common cause failures affecting multiple systems. All equipment required either to meet the 10CFR100 doses over this accident spectrum or to guarantee that the accident frequency is lower than once in ten thousand years should be specified as safety related.

The extent of the equipment that is safety-related will vary from one proposed standardized design to another. Some design concepts may utilize a few passive structures, systems, or components to meet the regulatory requirements; others may rely on more complex, active engineered safety features.

The safety function(s) of safety-related equipment must meet high standards in the areas of design, construction, and operation to provide assurance that the top level regulatory criteria are met The standards now in place have been developed jointly by industry, the professional societies, and by NRC and are adequate.

(10) In connection with standardized designs, should the NRC continue to adhere to the single failure criterion or should the NRC adopt the practice followed in a number of successful foreign nuclear programs of requiring four independent safety trains?

The single failure criterion is a first approximation to achieve high reliability. By requiring that one failure in an active safety system not compromise the plant's overall response, protection against two independent failures is provided. However, the single failure criterion alone does not protect against dependent failures, that is, one common cause affecting two or more redundant systems. The approach of some foreign programs of providing additional safety trains would not necessarily protect against common cause failures. The NRC should evaluate plant designs with modern risk assessment tools that consider single and multiple, independent and dependent failures rather than prescribe any set number of independent safety trains.

(11) In connection with standardization, should there be any change in what

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equipment is required to be inside the containment building?

The equipment required to be inside the containment, or even whether a containment is necessary, should be determined by the plant design and its safety evaluation compared to top level regulatory ceiteria.

(12) Once a standardized design has been approved by the NRC, under what circumstances should modification of that design, whether by the NRC or by the licensee, be permitted?

Once a standardized design has been approved by the NRC, modification of that design should be required if NRC requirements are formally changed or if it fails to meet its performance functions and requirements. Modification of the design by the licensee should be permitted if shown that it did not directly or indirectly affect the accomplishment of safety functions (also see answers to Question 14).

(13) What work has already been done on standardized plant designs? Is that work relevant today?

In the mid-1970's, GA sold five twin unit plants in the 770 to 1170 MWe range to U.S. utilities. A high degree of standardization was designed into these plants, which had many subsystems of identical design. Although these plants were cancelled or the sales withdrawn as a result of the collapse of the commercial nuclear market, joint programs sponsored by the Department of Energy and industry focused on the design, development, and optimization of HTGR concepts making extensive use of modularization and standardization.

Currently, the HTGR program is focused on a smaller, simpler, passively safe modular HTGR that is fully intended to have standardized subsysems for replication.

(14) For how long should a standardized design approval be effective? Please provide the underlying technical reasons for this time period.

A standardized design should remain valid and reuseable indefinitely or until one of the following events occur:

- The standardized subsystem is shown to not meet its Regulatory performance functions or requirements.
- The standardized subsystem design is changed to take advantage of state-of-the-art advances (i.e., new materials, components, etc.) that changes its Regulatory performance characteristics beyond approved limits.
- The standardized subsystem cannot meet more stringent safety criteria imposed by any formally changed NRC regulations.

The period of ten years, as proposed in the pending Congressional bills, is a minimum and unnecessarily arbitrary. It forces unnecessary review where only a few plants may be built in that time frame, and it does not allow for technology advances that come along before a ten year period is over. A "standard part" should be standard for as long as it is shown to be able to perform its intended function. A fixed period of time should be replaced with NRC verifications that approved Regulatory Standard designs continue to meet performance requirements in operating plants.

(15) **Much has been said about the need for all parties to the nuclear powerplant licensing process to exercise strict discipline. Please describe how such discipline was not exercised in the past by vendors, architect-engineers, constructors, and regulators. Please also describe the discipline which must be exercised by these parties in the future. What should be done legislatively to ensure this discipline?**

Since GA has not been directly associated with LWR plant design and construction in the past, we do not have a basis upon which to adequately comment.

We believe those entities that were directly involved in such situation are far more qualified to respond to this question. However, we believe the incorporation of standardized designs into the application for a one-step construction and operation license will provide discipline to the regulatory process.

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Energy Conservation and Power

Honorable Edward J. Markey
Chairman
Subcommittee on Energy Conservation
and Power
Committee on Energy and Commerce
U.S. House of Representatives
Washington, DC 20515

December 9, 1985

Dear Mr. Chairman,

Thank you for your letter of November 26 inviting Stone & Webster Engineering Corporation to testify at your hearing on Nuclear Power Plant Standardization to be held at 1:30 p.m. on December 10. We look forward to appearing at that time and presenting our views on the pending legislation.

Enclosed are our answers to the 15 questions included in your letter. We would appreciate having these responses included in the record of the hearings.

May I take this opportunity to congratulate you on calling for hearings on this legislation. Your initiative in seeking to address the causes of regulatory delay in the review of applications for nuclear power plants is ✓very much appreciated. It is our view that without substantial improvements in the licensing process, it is altogether possible that the nation might well be deprived of the nuclear option for generating electricity which will be so important to our future well being.

We appreciate the assistance of your most able staff in preparing for these hearings.

Very truly yours,

Gerry Fain

Gerald G. Fain
Vice President and
Manager, Washington Operations

Enclosure

ATTACHMENT 1
ANSWERS TO QUESTIONS

(1) How should the term "standardized design" be defined? How detailed a design should be required for a standardized plant design approval? Please be specific.

Standardization means different things to different people, and thus agreeing on a single definition of the concept is difficult. The licensing legislation submitted to Congress in 1983 by NRC was called a "Nuclear Standardization Act" during drafting. Difficulties encountered in the definition of the concept contributed to the move to change the title of the Act to "Licensing Reform Act".

We believe the following definition would probably be acceptable to most people: a "standardized" design is one intended for use many times at many site locations. Such a standardized design is often referred to as a "reference design".

This concept is one of the three acceptable approaches currently embodied in NRC regulations (10CFR50). The concept may be used for major portions of a plant (e.g., a "Nuclear Steam Supply System" (NSSS) or a "Balance of Plant" (BOP)) as well as for a whole plant. The "major portions" concept provides flexibility for utilities; thus, a utility may select from a limited number of combinations of standardized NSSS designs and standardized BOP designs.

The Commission should emphasize the need for "essentially complete" design information in applications but would stress that the applications should describe what is needed by NRC for review, i.e., detailed methods, procedures, and performance criteria, rather than design details of pieces of equipment. The guidelines should be consistent with recent Commission emphasis on regulations that are less prescriptive and more performance oriented, and would incorporate some of the characteristics of the Standard Design Approval concept discussed in the 1978 Policy Statement. These guidelines will also need to describe the inspections and tests that would be necessary to ascertain that detailed design and construction have been completed in accordance with the approved design specifications.

The standardized design would be defined in sufficient detail so that the NRC can approve it, i.e., make a determination that the design, when used for a plant constructed properly on an acceptable site, would present no undue risk to the public health and safety. Standardized design documentation would specify all of the design criteria and parameters, together with a considerable amount of detail on the implementation of these criteria.

Equipment layouts, process and instrumentation diagrams, control logic diagrams, critical structural details, design codes, and software such as computer programs and quality assurance would be part of the standardized design documentation submitted to NRC as part of the SDA application.

System components should be defined in terms of physical and performance specifications. For example, a pump would have a defined maximum dimensional envelope, orientation of nozzles, chemical and physical characteristics of the pumped fluid, operating environment, required flows and pressures, materials of construction, quality and test requirements, etc. A control system component would have both its required operational characteristics and failure modes defined. The methodology and acceptance criteria to be used in activities such as seismic and environmental qualification and stress analyses would also be detailed in the standardized design documentation.

There are some design details currently provided to NRC in a Final Safety Analysis Report that are not needed for the NRC to grant approval of a standardized design. These design details are primarily dependent on the specific component manufacturer chosen. Details such as seismic and environmental qualification results, final elementary diagrams, and final stress reports would be available during the detailed design and construction phases for review by NRC to confirm design implementation.

(2) What should be the scope of standardization? Should standardization be based upon complete plant designs or should it be based upon subsystems such as the nuclear steam supply system ("NSSS") or the balance of plant ("BOP")? What would be the regulatory advantage of standardization based on subsystems in view of the large number of possible combinations of subsystems? Wouldn't the number of possible variations defeat the purposes of standardization?

Standardization should be applicable to major subsystems, such as the NSSS or BOP portion, as well as to a "whole" plant design. The term "whole" plant is misleading because there are certain portions of a plant that cannot be addressed until a specific site is chosen. The most obvious are the cooling water systems, whether they be sea- or river-water, cooling towers, spray ponds, or other alternatives. The major portions of a plant can be designed for certain cooling temperature ranges but it is impractical to have available a myriad of different pre-approved cooling systems to apply to the particular site chosen.

We believe a standardization process that allows for standardized subsystems will not defeat the purposes and benefits of standardization. The significant resources required in terms of financial assets, experience, and technical capability will limit the number of standardized designs to perhaps a dozen or so. Establishment of standard interfaces for applications for standardized NSSS and BOP designs, as was done in Amendment 1 to WASH-1341, will aid in limiting the number of variations or combinations. The marketplace will then determine which combinations to select.

We also believe that the existing matching in a utility application of an engineer-constructor's (E/C's) BOP and a reactor manufacturer's (R/M's) NSSS will better serve the industry, providing advantages to all.

The traditional E/C's role--to serve directly as an agent to the utilities--would be preserved. In addition to providing customary services for the BOP, E/Cs should continue the traditional role of providing: 1) construction management, construction, and operating plant support services, 2) analyses and consultations on components, systems and materials provided by others, and 3) technical peer review on NSSS design and component solution approaches. The E/C's proven ability to execute complete projects, with complementary internal procedures and interdisciplinary practices and policies, have been well developed over a number of years. The E/C's role and execution capability, together with the vast body of nuclear plant technology developed by the E/C over the past few decades, must be maintained. R/Ms could establish over a number of years, via hiring and expansion, the necessary corporate-wide tools to perform a complete project but could only fine tune these skills through the execution of numerous projects over a much longer period of time.

(3) The three principal vendors in the United States--Combustion Engineering, General Electric, and Westinghouse--produce somewhat different versions of the nuclear portion of a plant, i.e., nuclear steam supply system, nuclear island, and nuclear power block. Would standardization be affected by the differences in approach between the three principal domestic vendors?

Standardization would be adversely affected by such differences. Each approach establishes vastly different interface points between the E/C and the R/M. Those R/M designs that diverge from the well established interfaces between E/C and R/M and approach the "whole plant" concept cause the greatest adverse impact. (See response to Question 2.) Stone & Webster has, to the satisfaction of the NRC, matched a single standardized design to three different NSSS designs with the well established E/C and R/M interfaces (i.e., BOP and NSSS), by clearly identifying differences in R/M interfaces in SWESSAR-P1. SWESSAR-P1 is Stone & Webster's standard safety analysis report which was the basis upon which the NRC granted three Preliminary Design Approvals to the Stone & Webster reference (standardized) plant.

(4) How would standardized subsystems be matched up? How would site specific factors, such as seismic design, be taken into consideration?

Standardized subsystems would be "matched up" by demonstrating that all interfaces between the subsystems have been identified and are compatible. ✓Stone & Webster did this to the satisfaction of NRC in SWESSAR-P1 (see response to Question (3)). Site-specific factors, such as seismic design, are taken into account by establishing site envelope parameters. SWESSAR-P1 established site-related criteria to be used as a basis for design. These criteria were sufficiently conservative to include a large number of prospective plant sites. Site envelopes were established for such parameters as ice and snow loadings; temperature ranges; meteorological conditions including atmospheric dispersion factors, tornadoes, hurricanes, and high winds; and seismological conditions such as ground acceleration and shear modulus of the geological material underlying the plant foundations.

(5) Under the standardization approaches currently being considered, could a standardized subsystem be matched up with a customized subsystem? If so, wouldn't this defeat the purposes of standardization?

Under the standardization approaches currently being considered, a standardized subsystem could be matched up with a customized subsystem. This might require a more extensive NRC review and hearing process to be invoked at the time of application for a plant license, to evaluate the interfaces between the customized and preapproved standardized subsystem. This fact would strongly inhibit the matching of customized subsystems with standardized subsystems. Therefore, the purposes of standardization would not be defeated and the option of using customized subsystems should be retained to accommodate special situations, such as when significant savings would be achieved.

(6) The legislation pending before Congress contains provisions dealing with both standardization and the combined construction permit and operating license based upon NRC's approval of an essentially complete plant design. Are these provisions interdependent or could standardization and the combined construction permit and operating license be implemented separately? Is legislation needed to accomplish both of these changes or could they be implemented by the NRC under its existing authority?

While standardization and the combined construction permit and operating license (COL) could be implemented separately, both provisions should be implemented together to achieve and enhance licensing stability. The benefits derivable from a major subsystems approach are discussed in the response to Question 2. Legislation is needed to establish a single-stage licensing procedure, that is, issuance of a COL. Present NRC practice under the existing Atomic Energy Act imposes a two-stage procedure for licensing nuclear power plants. The first (construction permit) stage requires a mandatory formal hearing. The second (the operating license) stage provides an opportunity for another hearing. Today, it is feasible to obtain final approval of essential design elements before construction begins because designs can be firmly established at the outset of the project.

It has been suggested, and it is certainly arguable as a legal matter, that most if not all of the concepts of regulatory reform could be achieved through administrative action. It is our position that regulatory reform needs to be accomplished by legislation, rather than through administrative action by the NRC, to be truly effectual.

Despite continued debate within and before the NRC concerning the merits of changes, definitive decisions and clear courses of action have not been developed. Moreover, many of the proposed changes are departures from long-standing policy and practice and might be subject to resistance from one or more Commissioners, the NRC Staff, and certain members of the public or special interest groups who wish to retain the status quo. The Commissioners apparently entertain doubts with respect to their latitude for a marked departure from present practice and are loath to take action. Leaving regulatory reform matters solely to the discretion of the NRC has not achieved substantive results in the past, and there is no assurance that such will be achieved in the future. In addition, administrative actions that change regulations, practice, and policy one month can change them back again the next month. Therefore, there is a pronounced need for legislatively imposed discipline on the process. In simplistic terms, Congress must express its intent and provide the legislation to make it happen.

For regulatory reform to become a reality, it must be a clear part of the law so that the utility industry can depend on it for future projects.

Until this is done, the industry will be quite reluctant to commit the resources necessary to make nuclear power plant standardization succeed. The Congress is the only body which can give the concept of regulatory reform the imprimatur of national policy approval.

Many people agree on the overall objectives of nuclear power plant regulation and most agree that the present system, due to the fluid nature of NRC regulation, is not achieving those objectives. Therefore, it is imperative that the Congress enact appropriate legislation.

(7) Should standardized designs be based on existing plant designs or should more advanced designs serve as the basis for standardization?

As a practical matter, standardized or reference designs of major subsystems of plants can and should be based on the proven and well-developed current generation of light water reactors (LWRs) in the near term. Thus, there should be no requirement for advanced design concepts to be brought forward, in order for standardization to proceed. Other design concepts may be very useful in the future, and should continue to be developed such that they may become candidates for standardization.

(8) What are the lessons to be learned from the current generation of plants? To what extent should safety and efficiency improvements be required for the next generation of plants? What safety issues, whether or not officially characterized as unresolved safety issues, should be resolved before the next generation designs are approved?

To list all the lessons learned from the current generation of plants would take more time and space than available. The lessons learned are an essential part of the broad base of experience already incorporated into current generation plants.

Therefore, the most important lesson learned from the current generation of plants is that current LWR technology has developed safe and proven plant designs. There are no significant safety or efficiency improvements that should be required for the next generation of plants. Safety improvements and resolution of significant safety issues have become a part of recently licensed plants.

Having satisfied the safety concerns, utilities are motivated to improve efficiency for financial reasons. Such improvements should not be legislated but will continue to come about as a result of the utilities' own actions, coordinated by organizations such as EPRI and INPO. These actions include greater attention to detail in maintenance, operation, and training and are resulting in improved performance.

(9) In connection with standardized designs, what should be the scope of "safety related" equipment and of non-safety related equipment? What standards should "safety related" equipment be required to meet?

The scope of "safety related" equipment in a standardized (or customized) design should be determined on the basis of functional criteria which, when properly implemented, provide assurance that the risk to the public is acceptable, i.e., that there is no undue risk. The functional criteria which yield this assurance are established in existing regulations and are well understood today. Thus, in accordance with 10CFR100, the safety related structures, systems and components are and should be those necessary to assure: 1. the integrity of the reactor coolant pressure boundary, 2. the capability to shut down the reactor and maintain it in a safe shutdown condition, and 3. the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to its guidelines. All other nuclear power plant structures, systems, and components are non-safety related.

Criterion 3 (above) now takes on added significance in light of extensive efforts underway by both industry and government to better define lower accident source terms. Lower source terms will reduce the number of, or alter the design requirements for, safety-related structures, systems and components because their failure would not result in exposures that would endanger the public. This reduction would result in lower costs to the ratepayers and, more importantly, will avoid the necessity to expend resources on activities not truly related to public risk.

The standards that should be applied to safety-related structures, systems and components are those nuclear industry standards now applied to items currently classified as safety-related. This includes adherence to the quality assurance requirements of Appendix B to 10CFR Part 50.

(10) In connection with standardized designs, should the NRC continue to adhere to the single failure criterion or should the NRC adopt the practice followed in a number of successful foreign nuclear programs of requiring four independent safety trains?

The NRC should continue to adhere to the single failure criterion. This criterion has withstood the test of time and has been proven as a criterion that protects the health and safety of the public. It must be remembered that the US nuclear program, the largest in the world, has an enviable safety record in which the public's health and safety has never been compromised. Therefore, there is no reason to arbitrarily require U.S. designs to have four independent safety trains rather than two full-size independent safety trains.

(11) In connection with standardization, should there be any change in what equipment is required to be inside the containment building?

The design development process includes determination of equipment location. Factors entering into the determination of what equipment is inside the containment building include such items as the amount of radioactive material contained in the equipment, the need to maintain the equipment during normal and abnormal situations, the adaptability of the equipment to the containment environment, the length of the connecting pipe and cable, and the characteristics of any leakage postulated to come from the equipment. Thus, the location is determined to satisfy various overall plant safety, regulatory, and operability criteria. We believe equipment location should continue to be based on the above factors. It is possible that lower source terms could result in some equipment location changes.

(12) Once a standardized design has been approved by the NRC, under what circumstances should modification of that design, whether by the NRC or by the licensee, be permitted?

Once a standardized design has been approved, no modifications of that design by either NRC or the licensee should be permitted unless it can be clearly demonstrated that the proposed change or backfit is justified. The justification must ensure that the proposed change or backfit does not increase public risk, and that the benefits outweigh the costs. Such proposed modifications to approved standardized designs should be considered only in the context of generic amendments to the design, not in individual plant licensing proceedings. All such proposed modifications should be evaluated using the criteria of the recently adopted backfit rule.

(13) What work has already been done on standardized plant designs? Is that work relevant today?

Stone & Webster Engineering Corporation is a pioneer in nuclear plant standardization. We began our efforts on standardization in the late 1960s and have participated in the NRC standardization program since its inception in 1972. We were the first engineer-constructor to receive a Preliminary Design Approval (PDA) from the NRC for a "reference" BOP design, in May, 1976, matching a specific NSSS.

Attaining our first PDA was the result of a commitment of hundreds of our engineering and design personnel over a decade to a project dedicated solely to this reference design. This effort included not only development of engineering, but also construction planning to ensure that the design was as efficient to construct as possible.

Since receipt of our first PDA in May, 1976, we have had our standardized BOP design approved relative to two additional reference NSSS designs and had requested approval for a fourth. These approvals required additional engineering of our reference design to provide proper interfacing with the particular NSSS. Even with this additional engineering, the vast majority of our BOP was maintained as a single standardized design. Our reference design was used in the first application, submitted by New York State Electric & Gas Corporation and Long Island Lighting Company, for a construction permit which incorporated both previously approved standardized BOP and NSSS reference designs. The application was, unfortunately, withdrawn due to reduced power demand.

Other industrial firms have been active in standardization including five U.S. R/Ms and four architect/engineers/constructors.

We also have been active in other types of standardization programs such as the NRC Topical Report Program. We have received NRC approval for topical reports on subsystems for our reference nuclear power plant, on an independent spent fuel storage facility, and on various software. In addition, we were the first engineer-constructor to receive, in 1974, NRC approval for a standard nuclear quality assurance program. We also have standardized our construction methods and procedures, such as material controls, handling and storage, steel erection, and concrete placement.

Our reference design is compatible with 90 percent of the prospective plant sites from a seismic design viewpoint, and has other design basis envelopes equally as encompassing in areas such as soil characteristics, meteorology, and hydrology. These envelopes are still applicable today. Although our design has not been formally updated to recent regulatory requirements, which primarily resulted from post-TMI activities, we have performed general design reviews which concluded that the vast majority of our reference design is still relevant today.

(14) For how long should a standardized design approval be effective? Please provide the underlying technical reasons for this time period.

A standardized design approval should be effective for an initial period of not less than 10 years. This time period is consistent with the time frame to construct a series of plants and receive operating feedback for design improvements. To promote predictability and stability in the licensing process, there should be a method to extend the design approval. This method should require the NRC to provide, in the same manner as specified in the recently adopted backfit rule, any reason for denial of the extension request.

(15) Much has been said about the need for all parties to the nuclear powerplant licensing process to exercise strict discipline. Please describe how such discipline was not exercised in the past by vendors, architect-engineers, constructors, and regulators. Please also describe the discipline which must be exercised by these parties in the future. What should be done legislatively to ensure this discipline?

The lack of a licensing process that would ensure the stability of a standardized design, coupled with the earlier evolutionary growth of the nuclear power industry, resulted in designs that were different from each other and which changed during the licensing process. Some of these changes were imposed without demonstrating that they added a significant increment to the level of safety. Other design changes were made as negotiating accommodation to expedite the licensing process. Some of the design changes resulted from changes in regulatory requirements, from a "better mousetrap" approach to engineering design, and from a desire for custom features. Many of these changes were claimed to be minor. However, a marginal or minor change never remains minor. Efforts previously performed had to be undone and redone, and any purported cost and schedule benefits were frequently lost. Nonetheless, many plants in the early 1970s included a fairly substantial amount of similarity to other plants. This, in fact, was one of the early initiating causes of standardization.

Nuclear plant standardization must carry with it the discipline of regulatory stability. This discipline must be exercised by everyone concerned with the engineering, design, licensing, construction, and operation of a nuclear power plant. "Everyone," in this case, includes the utility, the engineer-constructor, the reactor manufacturer, and federal and state regulatory authorities.

We believe that it is the combination of standardized reference designs and change control that will establish the much needed stability under the proposed single-stage licensing process. A legislative mandate to apply strict criteria in approving design changes to standardized designs, such as contained in the DOE proposal (H.R.2488), would enforce this discipline.

NATIONAL STRATEGIES FOR NUCLEAR POWER REACTOR DEVELOPMENT

PREPARED UNDER A GRANT FROM THE NATIONAL SCIENCE FOUNDATION

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EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

U.S. utilities contemplating the available technologies for new electrical generating capacity do not presently regard nuclear power as an acceptable option. No utility is currently planning to build another nuclear unit, nor are any new orders in prospect. Despite this, there is a broad range of plausible circumstances -- even including those in which electricity demand grows a good deal more slowly than the most recent mid-range forecasts of the government and the electric power industry -- under which the absence of the nuclear energy option could result in substantial economic and environmental penalties to the nation, beginning around the turn of the century. Though by no means certain, this prospect is sufficiently likely that the electric power industry, the nuclear supply industry, and the government should explore carefully the conditions that would foster a restoration of the competitiveness of nuclear power.

The economic and political difficulties presently confronting the nuclear industry raise fundamental questions regarding the purpose and organization of the nation's efforts to develop advanced nuclear power plant technologies. Specifically, what kind of effort to develop advanced reactor technology is appropriate in the present circumstances? What should be the goals of this effort? What should be its technical focus? And what are the appropriate roles for the Federal government and private industry in carrying it out?

The traditional view of nuclear power plant innovation, formulated during a period of rapid expansion of the light water reactor (LWR) population in the United States, held that increases in the price of scarce natural uranium resources would pose the primary threat to the competitiveness of nuclear power. This led to the selection of the liquid metal fast breeder reactor (LMFBR) as the centerpiece of the U.S. nuclear reactor development program. For the foreseeable future, however, the market position of nuclear power technology in the U.S. will primarily be determined by factors other than uranium consumption efficiency. The main obstacles to nuclear competitiveness are escalating and unpredictable construction costs and lead-times, unexpectedly low plant availabilities, high operating and maintenance costs, and high perceived risks both to public health and safety and to utility investors. Though some of these problems extend beyond the control of those most closely involved in the civil nuclear enterprise, others are more directly susceptible to the corrective efforts of industry and government. In particular, serious problems affecting both the management and the regulation of nuclear power plant technology have been identified in recent years, and the outcome of ongoing measures to improve the quality of management and regulatory performance will have profound implications for the future viability of the nuclear energy option.

But doing better with the existing technology should not be the only goal of those seeking to revitalize the nuclear power industry. Management and regulatory effectiveness is strongly coupled to the nature of the technology itself. Although there is clearly no technical 'fix' for all of the problems now facing nuclear power, potentially large opportunities exist for technological innovations which would reduce the demands placed on the builders, operators, and regulators of nuclear power plants, or which would enhance the attractiveness of nuclear power to utilities in other ways. The changed economic and political outlook demands a fundamental reexamination of the premises and goals of the nation's nuclear power plant development efforts.

If nuclear power is to figure in the capacity expansion plans of U.S. electric utilities in the near term -- say during the next decade -- the only plausible technical options are current or incrementally improved light water reactor systems. For LWRs to be considered seriously, the utilities would have to reverse their present judgement that the financial risks of new LWR projects are prohibitively large. On this timescale, evolutionary technical improvements, taken on their own, would not have a decisive effect on utility perceptions of these investment risks. In combination with institutional reforms designed to improve management and regulatory performance, however, their potential contribution should not be underestimated. The main targets of opportunity include the simplification of plant designs, smaller (400-600 MWe) LWRs, and the application of recent advances in robotics, instrumentation and control and information technologies. New developments in the reactor safety field may also provide important opportunities for design innovation.

Short run technological and institutional innovations notwithstanding, U.S. utilities nevertheless may still be unwilling to order new LWRs during the 1990s, even if -- as now seems likely -- they are faced with the need to build large amounts of new central station baseload capacity at that time. But a failure of conventional light water reactor technology to regain commercial acceptance during the next decade would not necessarily preclude an important role for nuclear power in the longer run. Moreover, a return to nuclear power in the early years of the next century could be stimulated by the commercial availability of new reactor systems which the utilities found more attractive than conventional or incrementally improved LWRs.

Because the restoration of utility confidence in conventional LWRs appears to hinge primarily on the successful implementation of complex, exacting regulatory and industrial reforms, the most plausible alternatives to LWRs are those whose commercial viability would be least dependent on the prior implementation of such reforms. Reactor systems which will require a smaller construction investment, which rely on passive as opposed to active engineered safety features, and whose fabrication can be more fully carried out in a controlled factory environment would best meet this criterion. The list of reactor concepts which could satisfy these requirements and which are already at a sufficiently advanced stage of development to make commercialization feasible by the turn of the century is quite short. It includes small and mid-size high temperature gas reactors; small liquid metal cooled reactors; and so-called 'inherently safe' light water reactors, of which the best-known example at present is the PIUS concept developed by ASEA-ATOM in Sweden.

Of the technologies that are in principle capable of providing virtually unlimited supplies of electricity in the long run, the liquid metal cooled fast breeder reactor is still the most highly developed candidate. But the uranium supply and demand outlook is now such that, even with a resumption of converter reactor ordering on a substantial scale, there is presently little likelihood that breeders could compete economically before the middle part of the next century at the earliest. With an expected timescale to commercialization of several decades, breeders must now be considered in the same general planning category as other inexhaustible electricity supply options such as nuclear fusion and the advanced solar-electric technologies. Because of their earlier stage of development, the latter systems have not previously been in direct competition with the breeder for scarce development resources.

Government intervention in support of the development and application of new civilian technologies can generally be justified in cases where private market processes, unaided, would fail to exploit the full social potential of technological advance. Several economic and political developments will create strong pressure for reductions in the level of Federal support for nuclear power plant technology development during the next several years, and further budgetary cutbacks seem certain. Nevertheless, there are powerful public policy arguments favoring a continuing government role in this area, and there is reason to believe that a significant level of Federal support for a well-balanced development effort, reflecting the new priorities of the nuclear sector, and with an appropriate sharing of costs and risks with private industry, will be sustainable despite the difficult political environment.

The following specific recommendations are put forward concerning what should be done in the reactor development field by both government and private industry over the next several years:

- Design innovations which would significantly enhance the attractiveness of light water reactors to U.S. utilities could be achieved by the end of the decade, and should be actively pursued as part of a broader effort to restore the competitiveness of the LWR option. The U.S. utilities should play a more active role in setting LWR design priorities than has been the case in the past. Moreover, cost sharing by the utilities will probably be a prerequisite for significant supplier and government participation. The most effective government role overall is probably the indirect one of promoting measures to strengthen the utility industry's internal research and development funding mechanism. Beyond this, government sponsored research should primarily focus on longer-run, generic technologies with general applicability to a range of reactor types.

- A much higher level of standardization in power plant design, manufacture and construction will be essential if the nuclear option is to regain competitiveness, and additional measures by utilities, suppliers and government will be required to achieve it. However, these efforts need not interfere with the active pursuit of improvements in light water reactor technology. The key to the success of standardization efforts lies in what transpires after the next LWR unit has been ordered. Since this is not likely to occur for several more years at least, there is ample opportunity to pursue technical improvements in the meantime without compromising the objective of standardization.

- A fundamental change in national policy priorities guiding advanced reactor development efforts is recommended. Previously, the main public policy objective was to develop breeder reactors in preparation for the time when uranium depletion and price escalation rendered light water reactor systems uneconomic. For at least the next decade, the main concern should be to prepare for the possibility that U.S. utilities will not regain confidence in conventional LWR technology. The primary goal should be to promote the development of innovative nuclear power plant systems which would compete more effectively with coal. In view of the potential economic and environmental risks of relying almost exclusively on coal for new electric power supplies over the next few decades, this goal should be actively pursued by public policymakers. Left to itself, private industry will almost certainly fall short of the societally optimal level of effort in this area. The technical emphasis should be on the development of small to medium-sized reactors fundamentally different from conventional LWR designs, relying to the maximum extent on passive safety features, and designed to minimize on-site construction requirements. The target window for commercialization should be the early years of the next century. Breeder reactors may yet assume the dominant role in the nation's electricity supply system that was originally envisaged for them, but not for at least another several decades, and for the time being the effort to develop a nearer-term alternative to light water reactors should be assigned a much higher priority.

(v)

- Of the candidate reactor concepts that might serve as alternatives to LWRs, no more than two should be selected for the next stage of development, and this choice should be made within the next two or three years. The principal candidates are the small and mid-sized high temperature gas reactors, small liquid metal reactors, and PIUS.

- If, as seems quite likely, a full-scale demonstration of the concept (or concepts) of choice cannot presently be financed, the focus of the next stage of development should be the construction and testing of a pilot-scale 'proof-of-principle' device by the early 1990s. Though a full-scale demonstration would be a more appropriate next step, the funds necessary for such a project are unlikely to be forthcoming in the near future from either the government or private industry. The construction of a proof-of-principle device is thus recommended as the next best alternative. The primary goals of such a project would be (1) to provide a tangible domestic demonstration of the principle of passive safety fairly rapidly and at modest cost, and (2) to gain maximum insight into currently unresolved technical and licensing issues. If started within the next two or three years and placed in operation by the early 1990s, such a project need not significantly delay the target commercialization date since, even without this intermediate step, a full-scale commercial demonstration probably could not be initiated for several years in any case. Moreover, the decision on whether to proceed with the latter would be made with the benefit of several years of practical engineering experience, and at a time -- in the mid-1990s -- when the future of conventional LWRs will be considerably clearer than it is today.

- The costs of the next stage of development should be shared by the government and private industry. Interested foreign suppliers could also be invited to participate. At this stage the exact cost-sharing formula cannot be specified. However, an unwillingness by either utilities or suppliers to contribute a significant fraction of the costs of the next step for a given technical option should be sufficient grounds to disqualify that option from further consideration.

- In parallel with the shift in reactor development priorities, a corresponding shift in priorities for nuclear fuel cycle research and development is also recommended. Next to the development and demonstration of safe waste storage and disposal technology, the primary objective should be to improve the economics of the once-through fuel cycle. There are virtually no credible circumstances during the next few decades in the U.S. under which spent fuel reprocessing and plutonium recycle would be economically justifiable or politically viable.

CHAPTER I: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1. INTRODUCTION

In 1984, nuclear power plants produced about 13% of the electricity consumed in the United States. At the end of that year 91 plants were operable, with a combined capacity of 76,700 megawatts. A further 36 units presently have construction permits. Five of these were recently deferred indefinitely. Of the remainder, the last is currently scheduled to enter service in 1991. By then, the total installed nuclear capacity will be a little over 110,000 megawatts, and the nuclear contribution to U.S. electricity supplies will have risen to about 20%.

Completion of the final unit will mark the end of the U.S. nuclear construction program for the foreseeable future. No utility is currently planning to build another nuclear unit, nor are any new orders in prospect. Although nuclear power plants are generating cheap, reliable power in many areas of the country, utility managers and investors now perceive the risks of adding new nuclear capacity as decisively outweighing the potential economic benefits (Ref. 1). Even the nuclear industry's main trade association, the Atomic Industrial Forum, concluded recently that nuclear power cannot at this time be considered a viable option for U.S. utilities (Ref. 2).

The utilities' retreat from nuclear power has actually been underway for a number of years. The rate of nuclear plant cancellations began to exceed the rate of new orders in 1975. The last new order was placed in 1978, and there have been more than 100 cancellations since 1974. None of the plants now in service or under construction was ordered after 1973.

A great deal has been written recently on the origins of the U.S. nuclear energy crisis (Refs. 3-4). This report addresses one particular aspect of the present situation. The current difficulties have raised fundamental questions regarding the purpose and organization of efforts to develop advanced nuclear power plant technologies. Given the economic and political conditions now facing nuclear power in the United States, what kind of effort to develop advanced reactor technology is appropriate? More particularly, what should be the goals of this effort? What should be its technical focus? And what are the appropriate roles for the Federal government and private industry in carrying it out?

This report concludes the second phase of a multiyear project at M.I.T. on research and development strategy in the nuclear power plant industry. The first phase of this project included a preliminary assessment of the potential role of technological innovations in reestablishing nuclear power as a competitive central station generation option for the U.S. electric power sector (Ref. 5).

The main findings of the earlier study provided the point of departure for the present one, and are summarized here:

- It is extremely unlikely that any orders for new nuclear plants will be placed by U.S. utilities before the end of the decade. Nevertheless, there is a broad range of plausible circumstances -- even including those in which electricity demand grows a good deal more slowly than the most recent mid-range forecasts of the government and the electric power industry -- under which nuclear energy could once again be called upon to supply an important fraction of the nation's new and replacement electricity supplies, and under which the unavailability of the nuclear option could result in substantial economic and environmental penalties to the nation beginning around the turn of the century. Though by no means certain, this prospect is sufficiently likely that the electric power industry, the nuclear supply industry, and the government should explore carefully the conditions that would foster a resumption of nuclear ordering.

- Several of the more important reasons why the electric utilities currently do not regard nuclear power as a viable option are beyond the control of the nuclear industry and the directly responsible agencies of government. This is clearly true, for example, of the uncertainties in electricity demand growth rates and the high cost of capital. Other problems are less obviously out of reach, but still revolve around issues -- political, constitutional, social -- which transcend the particular circumstances of nuclear power, and whose resolution would probably require the active participation of a broad array of affected groups. Such issues include, for example, the impact of the separate and overlapping jurisdictions of the states and the federal government on the climate of economic and environmental regulation; the rights of individuals and interest groups to intervene in regulatory proceedings, and the consequences for the predictability of the regulatory process; and the delay and uncertainty introduced by litigation and judicial review.

- On the other hand, some of the most important reasons for electric utilities not to build new nuclear plants are more directly susceptible to the corrective efforts of industry and government. Many of the worst problems to befall the nuclear industry have occurred as a result of its own management shortcomings; the best-known examples include mistakes in the execution of designs, mismanagement of construction projects, and poor operating practices. At the same time, the management of nuclear safety regulation, and in particular the performance of the Nuclear Regulatory Commission (NRC), has been flawed by ineffective and inefficient administrative procedures, internal organizational problems, and excessively prescriptive and occasionally counterproductive technical requirements. The importance of improving both the management and the regulation of nuclear power plant technology to the future viability of the nuclear option in the United States cannot be overstated.

- At the same time, doing better with the technology that is already available should not be the only goal of those seeking to revitalize the nuclear power industry. Management and regulatory effectiveness is strongly coupled to the nature of the technology itself. Potentially large opportunities exist for nuclear power plant design innovations which would reduce the demands placed on the builders, operators, and regulators of these plants, or which would enhance the attractiveness of nuclear power to utilities in other ways. Clearly there is no technical 'fix' for all of the problems facing the industry. Nevertheless, technological developments can be envisaged which could substantially improve the prospects for a resumption of nuclear ordering by the turn of the century or even earlier.

- The traditional view of the role of nuclear power plant innovation, formulated during a period of rapid expansion of the light water reactor (LWR) population in the United States, held that increases in the price of scarce natural uranium resources would pose the primary threat to the competitiveness of nuclear power. Consequently, the primary goal of innovation efforts was to ensure that nuclear power plant systems with suitably conservative uranium consumption characteristics would be available as required by depletion-driven uranium price increases. This reasoning led to the selection of the liquid metal fast breeder reactor (LMFBR) as the centerpiece of the U.S. nuclear reactor development program. The changed economic and political outlook for nuclear power demands a fundamental reexamination of the premises and goals of the nation's nuclear power plant development efforts. For the foreseeable future the market position of nuclear plants in the U.S. relative to each other and to alternative sources of electric power will be primarily determined by factors other than uranium ore consumption efficiency. The principal threats to the competitiveness of the nuclear option are escalating and unpredictable construction costs and lead-times, unexpectedly low plant availabilities, high operating and maintenance costs, and high perceived risks both to public health and safety and to utility investors.

- Possible technical responses to these new problems are of two kinds, one based on evolutionary improvements to existing light water reactor designs, and the other involving radically different design concepts. Proponents of an evolutionary strategy believe that the option of a major shift away from conventional light water reactor technology is unrealistic and illusory. They argue that it is wiser to draw on the great store of LWR experience in order to move incrementally towards an improved LWR system than to forego this experience in favor of an unproven concept; although the latter may offer advantages on paper, in practice it would almost certainly have to overcome an initial surge of unexpected problems similar to that which has plagued LWR technology and which is only now beginning to subside. Moreover, they point out the great practical difficulty of changing the technological course of an industry which for over two decades has been so strongly oriented towards LWR systems.

- Advocates of the alternative strategy suggest that an evolutionary approach by its very nature may be insufficient to address the fundamental problems that have arisen with nuclear power in the U.S. They argue that a more radical technological shift would not entail a completely new start; that a good deal of the existing LWR technology base is likely to be transferrable, irrespective of the direction of the shift; and that in the case of heavy water, liquid metal cooled, and graphite-moderated, gas-cooled reactor systems a large amount of directly relevant experience already exists both in the U.S. and overseas. It is also suggested that the reluctance of the electric power industry to contemplate major technological change may be significantly weaker a decade or so from now. Some proponents of this strategy take a stronger view, holding that disaffection towards conventional LWR technology in the electric utility industry and among the general public may be so strong, and the managerial and regulatory morass into which the industry has sunk so deep, that only a radical technological change could prompt a return to the nuclear option.

- In the ideal world of economic theory, the marketplace would be the arbiter of these opposing points of view. In practice, however, the high entry barriers and large risks and costs associated with major innovations in nuclear power plant technology mean that product competition is highly imperfect. Choices made far in advance of commercialization will limit the number and nature of the options that are eventually made available to the utility customer, and hence profoundly and irreversibly influence the direction of technological change. To this extent, predictive analysis must replace the 'invisible hand' of the market as a means of setting an appropriate technological course.

- Basic changes in the assumptions and policies of industry and government will be required to stimulate a more vigorous technological response to the current problems facing nuclear power. The electric utility industry, the nuclear plant suppliers and the government are all reluctant to undertake major new initiatives at this stage. The present Administration is philosophically opposed to government-funded commercial demonstrations of new energy technologies, a position which is reinforced by the present magnitude of the Federal budget deficit. Yet the utilities seem, if anything, even less likely than before to take a more active role in fostering nuclear innovation. For most -- faced with surplus capacity, uncertain demand growth, and public utility commissions often unfavorably disposed towards nuclear power -- there are few reasons to aspire to anything more than modest improvements which could be applied at low cost to plants already in operation or under construction. Indeed, there may be disincentives to go beyond this, created by fears that more radical innovations would undermine public or regulatory confidence in the utilities' existing nuclear investments. In turn, the current nuclear plant suppliers, whose previous design and manufacturing activities have generally been unprofitable, whose investment in the present product line may still not have been fully amortized, and whose future market prospects are at best uncertain, are most unlikely to allocate large amounts of risk capital to the development of advanced reactor designs in the absence of comparable commitments by others.

* * *

Taken together, these findings clearly indicated the need for a major review of the nation's nuclear power plant innovation strategy and suggested the general direction that such a review might take. But our initial assessment stopped short of defining and evaluating specific policy options for government and industry in this area. In the present study, we have examined in greater detail several key issues which we believe must be addressed in a comprehensive policy assessment. These include the following:

(i) Given the multiplicity of possible goals for innovative design efforts, the range of alternative technological approaches to these goals, and the limited resources that are likely to be available, what can be concluded on the basis of present knowledge with regard to the proper ordering of technical priorities?

(ii) Where the correct technical choices are not presently obvious, what additional information is required? More generally, what kind of process would be most likely to lead to a rational allocation of development resources?

(iii) What are the appropriate roles for the Federal government, the electric utilities, and the nuclear supply industry in promoting technical progress in the civilian nuclear field? How should the costs and risks of innovation be distributed among them?

(iv) What is the appropriate role of regulatory organizations, and of the Nuclear Regulatory Commission in particular, in the innovation process?

(v) What is an appropriate level of reliance on foreign research and development efforts, and in which technical areas is international cooperation likely to be most rewarding?

2. ORGANIZATION OF THE REPORT

The remaining chapters of this report explore these issues from a variety of perspectives. The authors originally presented their papers to a group of experts at a workshop held at M.I.T. on January 9-10, 1985. In addition to the main paper each chapter also includes a brief invited commentary and a summary of the subsequent discussion of the paper. (The workshop participants are listed in Appendix A, and the workshop agenda is given in Appendix B).

Chapters 2-4 present general assessments of the potential for design innovation in three areas of nuclear power plant technology: light water reactor systems (Michael Golay); liquid metal reactor systems (Michael Driscoll); and high temperature gas reactor systems (David Lanning and Lawrence Lidsky). In each case, the authors examine several possible targets for innovation efforts and identify outstanding technical issues whose resolution may have an important bearing on system performance.

In Chapter 5, Claus Goetzmann of Kraftwerk Union (KWU) examines the complex and controversial question of how capital costs scale with unit size in nuclear power reactor systems. He concludes that the application of standard scaling laws is of limited value in estimating the costs of smaller reactors, since such laws neglect both the cumulative effects of experience and the opportunities for design reoptimization which arise if the power output of the reactor is substantially reduced. Several specific examples of major design modifications developed by KWU for small, special purpose light water reactors are reported in this paper.

In Chapter 6 Isidor Weisbrodt of Interatom/Kraftwerk Union reviews small modular high temperature gas reactor designs and examines the extent to which the design simplifications made possible by the inherent safety features of the small reactors offset anticipated classical scaling effects. He concludes that the unit capital costs of high temperature reactor modules hardly vary over a range from 100 to 800 megawatts electric, but notes that some economies of scale will be exhibited by the balance of plant.

Charles Clark and Richard Fancher of Decision Focus, Inc. address the economies of scale question from a different perspective in Chapter 7. They present an electric power system capacity planning model which allows estimates to be made of the economic implications of construction lead-time and power rating variations for utility ratepayers and shareholders. The model indicates that in the current utility operating environment both ratepayers and shareholders should be willing to pay a substantial capital cost premium for generating units of smaller size and with shorter construction lead-times. Quantitative estimates of the value of size and lead-time reductions to each group are given for a range of hypothetical utility systems.

Differences in national industrial and political conditions may create significant international differences in the goals and priorities of nuclear power plant innovation efforts. In Chapter 8, Richard Lester presents a partial introduction to this question by exploring the effects of industrial organization and structure on the economic performance of the American nuclear power industry. He advances three general propositions concerning the relationship between structure and performance, and examines the empirical evidence bearing on each of them.

The Nuclear Regulatory Commission is widely seen as having a crucial influence on the prospects for nuclear power plant innovation. The regulatory environment will affect design choices, public perceptions, financial risks, and market prospects. In Chapter 9, Roger Mattson of International Energy Associates analyses the various options available to the Nuclear Regulatory Commission for establishing the general philosophy, technical criteria, and organizational approach to the regulation of a new generation of nuclear power plants.

Richard Lester attempts a synthesis of all of the preceding issues in Chapter 10. He first sketches several possible technical scenarios for the U.S. nuclear power industry, and then presents some general theoretical and empirical considerations regarding the Federal role in nuclear technology development and commercialization. Based on this discussion, several alternative reactor development strategies are evaluated. The paper concludes with a number of specific policy recommendations for both government and industry.

David Rose's summing up of the workshop as a whole is reproduced in Chapter 11. Chapter 12 contains the keynote address to the workshop participants delivered by David Saxon, Chairman of the MIT Corporation.

3. CONCLUSIONS AND RECOMMENDATIONS

On the basis of the results presented elsewhere in this report and the related research undertaken during the course of this study, we have arrived at the conclusions and policy recommendations summarized below. The findings reported here are those of the principal investigators of this research project, who take sole responsibility for them. They do not necessarily reflect the views of the other authors and commentators who have contributed to this volume. Nor should they be taken to reflect the views of the participants in the conference, though the latter may find some of their observations captured in various parts of the report.

Conclusions

1. If nuclear power is to figure in the capacity expansion plans of U.S. electric utilities in the near term -- say during the next decade -- the only plausible technical options are current or incrementally improved light water reactor systems. For LWRs to be considered seriously, the utilities would have to reverse their present judgement that the financial risks created by the unpredictability of LWR capital costs and construction lead-times are prohibitively large. On this timescale, the measures most likely to bring this about are, on the one hand, organizational changes and management reforms within the industry designed to produce higher quality, more consistent performance in plant construction and operation and, on the other hand, regulatory reforms designed to enhance the predictability of the siting and licensing process. These institutional reforms will not be easy to implement, however.

2. Conceivably, technological improvements could result in a qualitative change in the commercial outlook for LWRs; but it is more likely that even an aggressive pursuit of such improvements, taken on its own, would not have much effect on utility perceptions of LWR investment risks. In combination with institutional reforms their potential contribution should not be underestimated, however. The main targets of opportunity include the simplification of plant designs, the development of smaller (400-600 MWe) LWRs, and the incorporation of

recent advances in robotics, instrumentation and control, and information technologies; other important design goals should be to take maximum advantage of the opportunities for factory fabrication and for relying more heavily on such inherent safety features as natural circulation cooling. Regulatory changes arising out of new safety-related information are also likely to provide important opportunities for design innovation.

3. The active pursuit of improvements in light water reactor technology at this stage is entirely consistent with the effort to increase the degree of standardization in the nuclear power plant industry. A successful standardization strategy does not stifle all technical change, but rather incorporates it in a controlled manner. The main value of standardization is in the acceleration of learning through the repetition of design, construction and licensing tasks. The key to success thus lies in what transpires after the first unit has been ordered, and, in particular, in whether the utilities will then perceive the collective benefits of standardization strongly enough to suppress their individual design preferences (and also those of their suppliers) for long enough to capture a significant fraction of the available learning economies. But since the first new order for a light water reactor, if and when it occurs, is unlikely to be placed for several more years at least, there is ample opportunity to pursue improvements in the meantime, and technological competition among the remaining suppliers can play a positive role here.

4. Despite the best efforts at institutional reform and innovation in LWR technology, the difficulties presently confronting the U.S. nuclear power industry are sufficiently serious and persistent that the utilities may not overcome their present unwillingness to order new LWRs during the 1990s, even if faced with a need to build large amounts of new central station baseload capacity at that time. There is no basis on which to conclude, however, that a failure of conventional light water reactor technology to regain commercial acceptance then would preclude an important role for nuclear power in the U.S. during the first years of the next century. On the contrary, the present outlook suggests that this is a plausible scenario. A later return to the nuclear option could once again be based on LWRs. If so, it would rely heavily on imports of technology and equipment from overseas suppliers. Alternatively, on this somewhat longer timescale a return to nuclear power might be stimulated by the commercial availability of new reactor systems which the utilities found more attractive than conventional or incrementally improved LWRs.

5. To qualify as a plausible alternative to light water reactors, a new reactor technology must satisfy two general requirements. First, it must already be at a sufficiently advanced stage of development that commercialization by the turn of the century is feasible. And second, because the prospects for restoring utility confidence in conventional LWRs depend primarily on the successful implementation of complex, exacting regulatory and industrial reforms designed to reduce the

perceived financial risks of building those reactors, the most plausible alternatives to LWRs are those whose commercial viability would be least dependent on the prior implementation of such reforms. Reactor systems which require a smaller construction investment, which rely on passive as opposed to active engineered safety features, and whose fabrication can be more fully carried out in a controlled factory environment, would best meet this second criterion.

6. The list of reactor types which could conceivably meet both criteria is quite short. It includes small and mid-size high temperature gas reactors; small liquid metal cooled reactors; and so-called 'inherently safe' light water reactors, of which the best-known example at present is the PIUS concept developed by ASEA-ATOM of Sweden. Each has both advantages and liabilities relative to the others with respect both to ultimate commercial potential and feasibility of commercialization.

7. Development of a modular liquid metal reactor system would build on the extensive base of technology already assembled by the U.S. and overseas fast breeder reactor development programs. It could also draw on two major existing test facilities in the U.S., the Fast Flux Test Facility, and the experimental reactor EBR-II. Moreover, such an effort would simultaneously contribute to the longer-term goal of securing the availability of a breeder reactor system. On the other hand, the design concepts currently under active consideration all envisage a

closed fuel cycle. This would seem to be without economic justification for at least the next few decades. Moreover, the effort to close the fuel cycle would add significantly to the cost of development and commercial demonstration, and it would also invite a rehearsal of recent political difficulties over reprocessing and plutonium recycle. Proposals to mitigate safeguards problems by collocating reprocessing and fuel fabrication operations at the reactor site appear to be in direct conflict with the key goal of reducing the technical and organizational complexity of utility nuclear operations. Finally, there appears to be hardly any interest in the electric utility industry at present in liquid metal reactor technology as an intermediate-term generation option.

8. The PIUS concept makes no major new demands on fuel cycle technology. With regard to the reactor itself, however, the steam generator and possibly also the thermal insulation technology will require substantial additional development, and a prestressed concrete pressure vessel of the PIUS type has yet to be demonstrated commercially. Moreover, basic technical questions remain concerning the operability, maintainability, and reliability of the reactor. The readiness of the NRC to license PIUS without a containment building and without mechanical control rods is also an unresolved issue. These questions are fundamental to the commercial viability of the reactor and in some cases even to its technical feasibility, and can probably only be resolved through full or near full-scale testing.

9. The HTGR options are probably closest to a demonstration of commercial readiness. An important factor here is the advanced stage of development efforts in the Federal Republic of Germany and the opportunities for technological cooperation and cost sharing this affords. Another important consideration is that the HTGR options, unlike the others, can already claim a fairly broad constituency within the electric utility industry. Finally, the once-through HTGR fuel cycle is relatively straightforward in concept and the additional research and development requirements in this area will be quite modest.

10. Of the technologies that are in principle capable of providing virtually unlimited supplies of electricity in the long run, including nuclear fusion and advanced solar-electric technologies, liquid metal cooled fast breeder reactors are still the most highly developed, by a significant margin. It is generally expected, however, that the capital cost of breeder reactors will be higher than for light water reactors. Because of the predominance of the capital cost component in the total cost of nuclear electricity, even a modest breeder capital cost premium would not be offset by the benefit of reduced uranium consumption unless the price of uranium were far above its present level. But the uranium supply and demand outlook is now such that, even with a resumption of converter reactor ordering on a substantial scale, there presently seems little likelihood that uranium prices would approach the level required for breeders to compete economically before the middle part of the next

century at the earliest. With an expected timescale to commercialization of several decades, breeders must now be considered in the same general planning category of long-term, 'inexhaustible' electricity supply options as nuclear fusion and the advanced solar-electric technologies.

11. There are virtually no credible circumstances during the next few decades in the U.S. under which the reprocessing of fuel from light water reactors or alternative converters and the recycling of the recovered plutonium and uranium would be economically justifiable. Moreover, even if technological advances or other developments were to improve the economic outlook for reprocessing, formidable political obstacles to its commercialization would almost certainly remain.

12. Several factors will act to restrict the government role in nuclear power plant innovation efforts compared with previous years. A combination of large budget deficits and the philosophical preference of the present Administration for minimizing the extent of Federal intervention in energy markets is creating strong pressures for increased fiscal conservatism in this area, as in others. Moreover, the political fortunes of nuclear power are likely to be further eroded over the next few years as a number of very costly nuclear plants now approaching completion enter the ratebase in several states. Some level of Federal support is likely to be sustainable despite these developments. But the political climate is unlikely to be tolerant of requests for government

intervention which seem excessive, lack balance, or are otherwise poorly thought out.

13. Government intervention in support of the development and application of new civilian technologies can generally be justified in cases where the social benefits of technological innovation are not fully reflected in the cost-risk-benefit calculations of private innovators, and hence where private market processes, unaided, would fail to exploit the full social potential of technological advance. The application of this general criterion to the case of nuclear power must take account of the different development schedules and risk profiles characterizing different areas of reactor technology.

14. With regard to short-run efforts, defined here as those which might lead to commercial application within the next decade, the role of the government is limited. On this timescale, evolutionary improvements to conventional light water reactor systems are the only plausible target. LWR systems are already firmly in the commercial domain, where governments, and especially the present one, have generally been reluctant to intrude other than to conduct confirmatory safety research. Moreover, evolutionary technical modifications in any case can probably make only a limited contribution to the restoration of LWR competitiveness. One possible case for government support in this area might be made on the grounds that the stimulation of innovation would contribute to the preservation of key elements of the domestic LWR industrial

infrastructure, which private firms might otherwise allow to be dissipated during the next few years. The extent to which such measures would actually contribute to the public interest is arguable, however. Whether or not U.S. design teams are disbanded, equivalent capabilities will remain intact in other countries with more active LWR industries, and will therefore be accessible to U.S. utilities. Further work is needed to quantify the benefits and costs of government intervention to preserve domestic LWR design autonomy. A separate case for government support might be made on the grounds that existing public policies pose significant obstacles to private innovation. Here, the efficacy of attempting to compensate for these obstacles through direct public support of research and development must be compared with the alternative of concentrating on removing the obstacles themselves. Finally, whatever the theoretical justification for government support of LWR improvement efforts, as a practical political matter such support is not likely to be forthcoming in the absence of a serious complementary initiative by the industry itself.

15. With regard to the longer term, the public policy considerations bearing on the development of new reactor systems have recently undergone a fundamental change. Previously, the primary concern of Federal policymakers was to ensure an appropriate level of effort on breeder reactor development in preparation for the time when LWR technology was rendered uneconomic by virtue of its own success and the consequent depletion of uranium resources. This scenario is now overshadowed by the possibility that the U.S. utility industry will not

overcome its present unwillingness to consider additional LWRs of conventional design, even if -- as seems quite likely -- it is faced with the need to build large amounts of new central station capacity starting in the 1990s. Since the alternative -- almost total reliance on coal for additional power supplies over the next few decades -- could bring with it serious economic or environmental consequences, or both, careful public policy attention should be paid to ways of averting this possible outcome. A promising longer run approach is to promote the development of innovative nuclear power plant systems which would provide more effective competition for coal than conventional LWRs. Left to itself, private industry will almost certainly fall short of the societally optimal level of effort in this area. The market dominance achieved by LWRs in the past has created a major disincentive to private investment in alternatives. The possibility that LWRs will after all regain the favor of the utilities cannot be ruled out at this stage; and in direct commercial competition, the great advantage in accumulated experience enjoyed by light water reactor technology would pose formidable and perhaps insurmountable barriers to the entry of relatively untried alternatives. Paradoxically, another deterrent to private investment in alternatives has been created by the more recent failures of LWR technology, and the disgruntlement that these failures have fueled among the public and its elected representatives. It is in the nature of public opinion concerning nuclear issues that much of this legacy of disaffection will be indiscriminately directed towards all things nuclear, thereby adding both to the importance and to the difficulty of the task of product differentiation facing the developers and marketers of alternative technologies. The difficulty here is compounded by a probable desire in the electric utility industry -- of which there is already some evidence -- to de-emphasize these differences out of concern that a significant departure from conventional light water reactor designs, if it appeared to be motivated by an effort to reduce safety risks, would undermine public or regulatory confidence in the utilities' existing nuclear investments. Other factors inhibiting private investment in this area include current perceptions of high regulatory risks in both the economic and safety arenas, the long lead-time (~15 years) for commercializing a new technology, and the high costs of commercialization.

16. The appropriate level of government support for the development of alternative reactors is a complex function of expectations regarding (1) the possibility that shorter-run efforts to restore the competitiveness of LWRs will fail; (2) the magnitude of the economic and environmental risks associated with a strategy of almost exclusive reliance on coal for new electric power supplies over the next few decades; and (3) the efficacy of advanced nuclear reactor development relative to other technological or regulatory measures in alleviating these risks. The issues here are complex and the uncertainties are obviously very large. At a minimum, however, we believe that the goal of developing innovative reactor systems as alternatives to LWRs for possible commercialization around the turn of the century should be

assigned the highest priority in the Federal government's advanced civilian nuclear reactor development program.

Policy Recommendations

We now offer some specific proposals concerning what should be done in the reactor development field over the next several years. Our recommendations do not constitute a detailed, comprehensive program for reactor development. The purpose is rather to provide a framework for evaluating narrower, more detailed proposals advanced by advocates of particular technical paths. While our individual recommendations may require revision as a result of as-yet unforeseen developments, we believe that they constitute a sensible point of departure for a national policy debate on this subject. In particular, we believe that they are based on fairly realistic expectations concerning the amount of public sector funding that is likely to be available during the next several years. Our main assumptions in this regard are that government-funded commercial demonstrations of new reactor technologies will not be feasible politically, and that the total amount of Federal funding potentially available will probably fall short of that which the breeder program alone has been receiving in recent years.

1. Design innovations which would significantly enhance the attractiveness of light water reactors to U.S. utilities could be achieved by the end of the decade and should be actively pursued as part of a

broader effort to restore the competitiveness of the LWR option. Although design improvement programs in progress overseas can provide useful inputs to such an effort, differences in national industrial and political conditions mean that the design priorities of the U.S. utility industry may differ significantly from those in countries where LWR technology has recently enjoyed greater success. Under U.S. conditions, innovations leading to reductions in the scale of the initial construction investment and in the complexity of site construction, plant operation and maintenance procedures are likely to be valued particularly highly. The U.S. utilities should play a more active role in setting LWR design priorities than has traditionally been the case. Without the active technical participation of the utilities, LWR innovation efforts will be much less likely to succeed. Moreover, cost sharing by the utilities will probably be a prerequisite for significant supplier and government participation in this area. Because of the short timescale of these efforts, direct government support will probably be limited in scope. Perhaps the most effective government role overall would be the indirect one of promoting measures to strengthen the utility industry's internal research and development funding mechanism. Beyond this, government sponsored research should primarily focus on longer-run, generic technologies with general applicability to a range of reactor types.

2. A much higher level of standardization in power plant design, manufacture and construction than has previously been achieved will be

essential if the nuclear option is to regain competitiveness, but during the next few years this goal should not be allowed to restrict efforts to improve upon current LWR designs. Even with no further action, several recent and continuing developments will ensure a greater degree of standardization should LWR ordering be resumed: the principal reactor vendors have each recently introduced standard nuclear steam supply system designs; and the continuing attrition among secondary suppliers caused by the absence of orders will also contribute in this regard. Moreover, a self-selection process can also be expected to operate within the utility industry in the future, with ordering confined to that subset of utilities whose previous experience with LWRs has been satisfactory. Beyond this, several additional measures should be taken, but none need conflict with efforts to develop advanced LWR designs.

The two most important steps for the electric utilities to take would be (1) to collaborate in the development of a set of standard design requirements for future light water reactor plants and (2) to commit themselves for a specified period to accept without significant modification standardized plant designs which meet these requirements and have received NRC certification.

For the nuclear power plant supply industry, the most important additional step would be the formation of integrated supply consortia, encompassing the entire plant. A consortium would consist of an NSSS vendor, an architect-engineer and one or more primary component manufacturers. One member, presumably the NSSS vendor, would assume overall management responsibility for the design and engineering of the entire plant, or, at a minimum, all of the safety related parts of the plant. Ideally, the consortium would also be prepared to supply the standardized units on a fixed-price, turnkey basis.

As long as responsibilities for the supply and ownership of nuclear power plants are expected to remain largely within the private sector, the government is constrained to a limited role in support of standardization. The main function of the government should be to reduce whatever obstacles to standardization are created by existing public policies. The biggest such obstacle at present is the perception within the industry of regulatory instability. Expectations of a continuing stream of new requirements from the NRC tend to undermine industrial incentives to standardize. Industry concern will be alleviated as the list of currently unresolved safety issues contracts. This will require continuing Federal support of NRC research and regulatory development activities. Organizational restructuring and procedural innovations within the Commission can also help to reduce concern over regulatory instability and provide additional incentives for industry standardization.

3. We recommend a fundamental change in national policy priorities guiding advanced reactor development efforts. Until recently, the main public policy objective was to develop breeder reactors in preparation

for the time when uranium resource depletion and price escalation rendered light water reactor systems uneconomic. For at least the next decade, the primary goal of advanced reactor development should be to prepare for the possibility that U.S. utilities will never regain sufficient confidence in conventional LWR technology to order new plants. The main target of these efforts should be to reduce by a substantial margin the capital costs and the financial risks of nuclear power plant investments. The emphasis should be on the development of small to medium-sized reactors fundamentally different from conventional LWR designs, relying to the maximum possible extent on passive safety features, and designed to minimize on-site construction requirements. The target 'window' for commercialization should be the early years of the next century.

Breeder reactors may yet assume the dominant role in the nation's electricity supply system that was originally envisaged for them. But this role, if it materializes at all, will not need to be filled for at least several more decades. Some difficult budgetary decisions will soon have to be made concerning the proper balance among all the long-term electric power options, including breeder reactors, fusion, and advanced solar electric technologies. But while this question -- which was not addressed in this report -- can probably be deferred for a few more years, the effort to develop a nearer-term alternative to the LWR cannot, and for the time being the latter should be assigned a much higher priority in budgetary allocations.

4. Of the candidate reactor concepts that might serve as alternatives to conventional light water reactors by the turn of the century, we recommend that no more than two be selected for the next stage of development, and that this choice be made expeditiously (i.e. within the next two or three years). The principal candidates are the small and mid-sized high-temperature gas reactors, small liquid metal reactors, and PIUS. The need to reduce the field of contenders is dictated by the limited funding that is likely to be available for the next stage of development.

5. If, as seems quite likely, a full-scale demonstration of the concept (or concepts) of choice cannot presently be financed, the focus of the next stage of development should be the construction and testing of a pilot-scale 'proof-of-principle' device by the early 1990s. In the absence of resource constraints, a more appropriate next step would be to construct a full-scale reactor system to demonstrate all of the key features of the concept from the user's perspective, including construction cost and lead-time, licenseability, and plant reliability. But the present Administration is opposed to funding near-term nuclear reactor demonstrations; and without substantial government support, and with the future of conventional LWR technology still unresolved, the necessary funds for such a project are unlikely to be forthcoming from the private sector. The construction of a pilot-scale proof-of-principle system is thus recommended as the next best alternative. The primary goals of the project would be (1) to gain maximum insight into

currently unresolved technical and licensing issues, and (2) to demonstrate the principle of passive safety to concerned groups in the most cost-effective way. Achievement of these goals would significantly reduce the uncertainties of a subsequent commercial demonstration stage. The decision on whether or not to proceed with the latter would be made with the benefit of several years of practical engineering experience, and at a time -- in the mid-1990s -- when the future of conventional light water reactors will be considerably clearer than it is today. Moreover, the proof-of-principle project, if started within the next two or three years and placed in operation by the early 1990s, need not delay significantly the target commercialization date since, even without this intermediate step, a full-scale commercial demonstration project probably could not be initiated for several years in any case.

The costs of a proof-of-principle project should be shared by the government and a consortium of utilities and suppliers. Interested foreign suppliers could be invited to participate. Although the exact cost-sharing formula can only be guessed at, we believe that significant private sector contributions would be both politically necessary and, by virtue of the active involvement of the sponsors they would engender, important to the technical success of the project. Indeed, an unwillingness by either utilities or suppliers to contribute a significant fraction of the costs of the next step for a given technical option should be sufficient grounds to disqualify that option from further consideration. The application of this criterion may very well be sufficient to reduce the field of contenders to the size recommended above.

If the modular high temperature gas reactor concept is selected, an appropriate proof-of-principle device would be a small test reactor. The reactor would be used to provide tangible domestic demonstrations of the principle of inherent safety fairly rapidly and at modest cost, and subsequently for component, materials and fuel development and testing, and for safety-related tests. If the modular LMR concept is selected, a similar proof-of-principle reactor could be constructed. In this case, one of the existing test reactors, FFTF or EBR-II, might be adapted for this purpose. For the reasons cited previously, however, we believe that for an LMR to be a plausible alternative to conventional LWR technology by the turn of the century, it would need to be designed to operate economically on a once-through fuel cycle.

6. In parallel with the shift in reactor development priorities, we recommend a corresponding shift in priorities for nuclear fuel cycle research and development. In particular, we believe that next to the development and demonstration of safe waste storage and disposal technology the primary objective should be to improve the economics of the once-through fuel cycle. We further believe that no public funds should be allocated to the commercialization of spent fuel reprocessing and plutonium recycle technologies before the end of the century. If the

viability of the nuclear power option is restored in the U.S., reprocessing may become economic at a later date. But whether conventional LWR technology or an alternative reactor system is the vehicle for the recovery, initially the most competitive fuel cycle configuration will be the once-through scheme, and this is likely to remain true for at least two or three decades thereafter. Thus, the technical innovations in the fuel cycle with the greatest impact on the economic viability of the nuclear option for the foreseeable future are those which will improve the economics of the once-through cycle. The major contribution that the Federal government can make in this area is in the continued development of advanced uranium enrichment technologies. The cheaper separative work promised by the laser isotope separation and advanced centrifuge technologies will reduce fuel cycle costs and increase the amount of energy which can be economically extracted from natural uranium ores.

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THE MODULAR HIGH TEMPERATURE GAS-COOLED REACTOR: CURRENT STATUS, COMMERCIAL POTENTIAL, AND A PLAN FOR NEAR-TERM ACTION

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1. INTRODUCTION - MHTGR POTENTIAL

Gas-cooled, graphite moderated reactors have a long history: the first man-made reactor was both air-cooled and graphite-moderated. From this early test reactor, the gas-graphite family has expanded in time to encompass a wide range of designs, several multinational development programs, and over 50 operating reactors. Although this paper acknowledges the several gas-cooled reactor types, it is primarily focused on a particular subset, the so-called modular high temperature gas reactor now in the conceptual design phase in the United States and in the FRG. The acronym for this reactor type is MHTGR in the U.S., MHTR in Europe. We will further restrict detailed discussion of the MHTGR to those using microencapsulated ("coated particle") pebble-bed fuel.

The major design features of the pebble-bed reactor using coated particle fuel can be traced back to the early days of the European Dragon project, circa 1960 (Ref. 1). Development has been nearly continuous since then. The most recent example of this reactor type is the West German THTR-300 which achieved criticality in 1983 and is scheduled for full power commercial use in 1985 (Ref. 2). More to the point, the 40 MWt AVR operating at KFA-Julich since 1967 exhibits many of the essential features of the proposed commercial reactor module. Although no exact scale MHTGR has yet been built, the technological basis for the conceptual designs is well-developed and extensively tested. In fact, THTR-300 is actually much larger than the proposed MHTGR.

We believe the MHTGR concept has attributes that make it particularly well suited to U.S. utility requirements as they have developed over the past decade and as they are predicted to continue into the next century. These attributes include:

- Reduced financial, health, and safety risks (both perceived and actual);
- More predictable plant capital costs;
- Shorter and more predictable construction lead time;
- Higher reliability, availability;
- Higher efficiency, less environmental impact;
- Flexible plant size;
- Fuel form well suited for direct disposal;
- Simple upgrade path via fuel replacement;
- Simple, long-response-time control requirements;
- Good match to eventual export market;
- Potential extension to direct-cycle gas turbine; and
- Unique potential for high temperature process heat application.

We believe the outstanding technical issues with regard to the use of the MHTGR for electric power production can be entirely resolved by 1990 (indeed, some say they are resolved now) and the institutional issues important to unimpeded commercialization by 1995. We foresee the possibility of substantial commercial introduction by the year 2000 with the MHTGR becoming the dominant reactor type of the second nuclear generation much as the LWR was of the first.

2. TECHNICAL REVIEW

A. Modular Reactors

The acronym "MHTGR" used here will refer specifically to ceramic fueled, gas-cooled reactors so designed that:

(i) no credible combination of active system failure and/or operator error can cause risk to public health; and

(ii) the investment risk (the product of investment magnitude and probability of loss) is orders of magnitude less than other risks routinely assumed by operating electric utilities.

There are increasing indications that these requirements can best be met by reactors of relatively small size (approximately 250 MWt). Because this power level is small compared even to the 400-600 MWe plants, apparently most suitable for near term deployment (Ref. 3.), a number of identical reactor units (modules) will be used as heat sources in such power plants.

We note that modularity, in itself, is not always a high priority design goal and for some systems is not even a desirable one. Here, modularity comes about as an indirect consequence of requirements (i) and (ii) above, not as an a priori requirement. Although (i) and (ii) might be met by other designs (e.g., a large HTGR with annular core), there are obvious advantages for modularity. Serial factory production and licensing simplification are the most obvious benefits of modularity but many other financial, construction, licensing and operational issues can also be considerably simplified if the nuclear steam supply systems are identical and of modest size.

It is not enough just to design a miniature version of an existing large reactor. Most nuclear reactor systems do, indeed, become "safer" as their power density and unit size are reduced. However, unless such systems are mechanically simple, they tend to suffer badly owing to scale economy factors. Although most "downsized" light water and liquid metal cooled reactor designs are somewhat more forgiving than their larger progenitors, they still require multiply-redundant cooling and complex control systems. In many cases, the design needed to achieve passive cooling of the smaller units, especially in the case of the liquid metal designs, is actually more elaborate than it is in larger systems.

Modular size (250 MWth) HTGRs meet the requirement of design simplicity. However, that property in itself is not sufficient because unless they also possess extraordinarily simple operational and maintenance characteristics, the complexity of interconnected, multi-module systems soon becomes overwhelming. The use of pebble-bed technology (described in more detail below) limits excess reactivity to the point where inherent processes play the dominant role in reactor control. It is the combination of design simplicity with unique operational characteristics that makes the small, gas-cooled pebble-bed HTGR the system of choice for multi-module installations. Although there are proponents of both prismatic cores for modular reactors and pebble-bed cores in larger reactors, we believe that the combination of pebble beds with small sizes offers unique advantages. We limit this discussion to systems of this type.

Gas-cooled, graphite-moderated reactors have had many advocates, motivated by recognition of the advantages inherent in single phase, neutronically transparent coolants and high heat capacity, high mechanical strength moderators. The first commercial embodiment was the MAGNOX reactor, pioneered by the U.K. Atomic Energy Authority, and installed also in France and Japan. These reactors, designed over thirty years ago, utilize carbon dioxide coolant and natural uranium metal fuel with metal cladding. The MAGNOX reactors continue to operate successfully but they are limited in operating temperature and fuel burnup and are now being superseded by the AGRs (advanced gas reactors) using uranium oxide fuel in stainless steel cladding. The AGRs have higher specific power ratings and produce higher temperature steam, one of their major design goals. Nonetheless, the AGRs are somewhat expensive and are still limited by the chemical reactivity of the CO_2 coolant.

The High Temperature Gas-Cooled Reactor (HTGR) is distinguished from other gas-cooled reactors by its all-ceramic core and the use of ceramic coated fuel particles. The essential elements of the HTGR were developed between 1955 and 1960 when Peter Fortescue of Harwell Atomic Energy Laboratory in the U.K. (and later of General Atomic) pioneered the use of uranium/thorium fuel in all-ceramic cores, Rudolf Schulten of the Max-Planck-Institut developed the pebble-bed concept (using fuel bound in a moderator matrix), and R. Huddle, also of Harwell, developed the technique for pyrolytic carbon coating of submillimeter scale fuel particles (Ref. 1).

In the U.S., the very successful operation of the Peach Bottom HTGR was an important demonstration of the HTGR concept; much of this experience is directly applicable to MHTGR design considerations.

B. AVR

The first pebble-bed reactor, and still the most relevant to the MHTGR, as defined here, was the Arbeitsgemeinschaft Versuchsreaktor (AVR) designed and built by Brown-Boveri-Krupp Reaktorbau GmbH (a predecessor of HRB) at KFA-Julich (Ref. 4).

AVR is a 40 MWt developmental HTGR generating 15 MW of electricity via a conventional steam cycle. Ordered in 1959 and completed in 1967, AVR was built to demonstrate the safety and reliability of the HTGR concept. Subsequently, it became, and continues to be, an invaluable test bed for fuel testing and component development. In 1974 the core outlet temperature was raised to 950°C to demonstrate its high temperature capabilities for use as a process heat source. It has continued to operate at an outlet temperature of 950°C since then. The balance of the system presently operates at lower temperatures although complete high temperature circuits are under consideration.

Figure 1 illustrates the essential features of AVR. The reactor core is a short, but otherwise quite typical, HTGR core 2.47 m high and 3.00 m in diameter. The core is surrounded by a graphite reflector containing the control rods; there are no in-core operating rods. The shutdown rods are housed in graphite channels adjacent to the reflector. The helium, at a pressure of 10.9 bars (1.1 MPa), is circulated upward through the core, exiting at 950°C. The steam generator position, vertically above the core in the same steel pressure vessel, is an AVR-specific design feature. Although the steam generator has functioned well in this location at AVR, with ten years of operation before the first significant leakage, the optimum position for the steam generator in a commercial unit is still undecided; in fact, it is one of the major design differences between the two most highly developed conceptual MHTGR designs.

The AVR core contains 94,000 fuel elements ("pebbles") in the form of 6 cm diameter spheres. These spheres are continuously cycled through the core during operation; about 600 elements are removed from the core each day. Upon removal, each fuel element is individually measured for

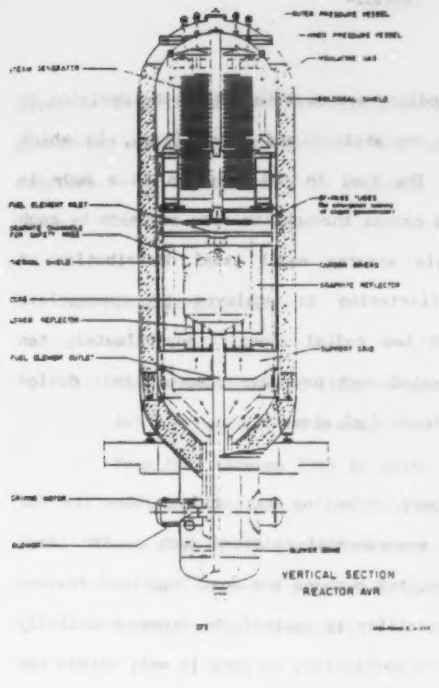

OUTER PRESSURE VESSEL
INNER PRESSURE VESSEL
STEAM GENERATOR
BIOLOGICAL SHIELD
FUEL ELEMENT INLET
BY-PASS TUBES
GRAPHITE CHANNELS FOR SAFETY RODS
THERMAL SHIELD
CARBON BRICKS
GRAPHITE REFLECTOR
CORE
LOWER REFLECTOR
SUPPORT GRID
FUEL ELEMENT OUTLET
DRIVING MOTOR
BLOWER
VERTICAL SECTION
REACTOR AVR

FIGURE 1. AVR

TECHNICAL DATA

elect. power	15 MW
therm. power	46 MW
core diameter	3 m
core height	2.47 m
power density	2.6 MW/m^3
moderator	graphite
coolant	helium
helium pressure	10.9 bar
max. helium temperature at core outlet	950 °C
steam temperature	505 °C
steam pressure	73 bar

[From Ref. 4]

burnup by an automatic fuel handling system after which the decision is made, again automatically, as to whether and where (i.e., in which radial zone) to recycle it. The fuel in AVR operates in a mode in which, on the average, about 10 passes through the core are made by each individual fuel element. This assures equal axial distribution of reactivity. Radial power flattening is achieved by appropriate recycling of the fuel through two radial zones. Approximately ten percent of the 600 elements tested each day have reached their design burnup; these are replaced by fresh fuel elements.

Continuous on-line, on-power refueling has obvious benefits for commercial use and also makes experimental reactors such as AVR ideal for fuel testing. Less obvious, but perhaps the most important feature of continuous refueling is the ability to control the excess reactivity in the core at all times and, in particular, to keep it well within the control range of inherent negative reactivity processes. It is this feature, in conjunction with the limited diameter of the MHTGR, that makes it possible to eliminate in-core control rods. Such continuous, fine control of core reactivity is much more difficult and often impossible for batch-fueled systems and represents an essential difference between HTGRs using encapsulated fuel in large fuel blocks ("prismatic" fuel) and those using pebble-bed fuel. There appear to be clear advantages for the pebble-bed technology in the small scale, modular HTGR where "absolute" inherent safety is the goal and control rod insertion directly into the pebble bed is disallowed.* The relative merits of pebble-bed and prismatic fuel are not nearly as clear in larger HTGR reactors -- in fact, there is a strong divergence of opinion on this issue.

AVR has demonstrated:

(1) High overall availability of pebble-bed reactors:
AVR has recorded an average overall availability of 68 percent from 1967 through 1983 in spite of the fact that it is an experimental plant. The average availability from initial startup was 77 percent through 1978 when a steam generator failure caused a protracted outage. In 1976 AVR achieved an average annual availability of 92 percent.

(2) Flexibility of the pebble-bed concept:
Ten different types of fuel elements have been used in AVR. The initial loading used highly enriched mixed uranium/thorium carbide fuel. In 1974 the uranium/thorium oxide fuel developed for THTR-300 was introduced and tested. These and other early fuel elements relied on a single pyrolytic carbon

---

*The large and uncertain forces needed for rod insertion directly into the pebble bed itself may be unacceptable for technical and regulatory reasons in the U.S.; the use of in-core rods is sanctioned in Germany.

coating for fuel and fission product retention (BISO particles). In 1982 the core began a gradual changeover to low enriched uranium oxide fuel with silicon carbide encapsulation between two pyrolytic carbon shells. These so-called TRISO fuel particles stem directly from the Peach Bottom experience. TRISO fuel is particularly suitable for high temperature operation and shows vastly improved radioactive product retention in the event of temperature excursions during an accident.

(3) Inherent safety:

During normal operation, the power level of AVR is controlled by the helium flow rate and the inherently large negative temperature coefficient of reactivity. The external control rods are used merely to determine the set-point operating temperature. Several redundant schemes are provided for cold shutdown of AVR but their rapid operation is not required for either safety or investment protection. The most dramatic demonstration of the inherent safety characteristics of AVR was provided by an experiment in which coolant flow was instantaneously interrupted at full power operation by turning off the blowers and simultaneously closing the gas valves situated between the blowers and the core. The reactor shut down immediately under control of the inherent negative temperature coefficient even though the control rods were not moved and no shutdown rods were introduced. In this experiment, the moderator temperatures increased locally in some positions but the fuel temperatures never exceeded peak normal operational values.

(4) Maintainability:

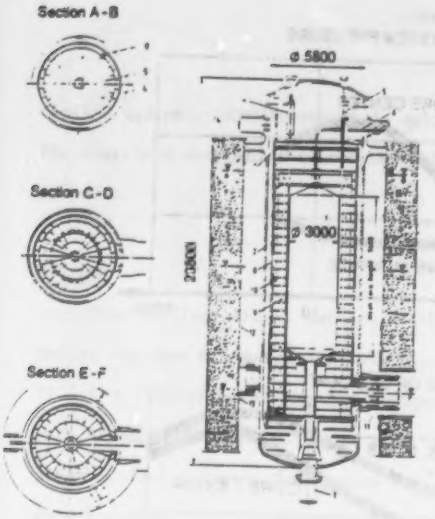
Except for one batch of experimental carbide fuel which released excessive strontium contamination at very high burnup, the fuel elements have shown the expected high retention capability for fission products. For the seven years of operation before the strontium release, it was possible to change components of the fuel handling system without extra personnel shielding, i.e., the primary circuit contamination was extremely low. Since changeover to TRISO coated particles with improved retention properties, additional contamination has been extremely low and plateout of radioactive products in the primary system has been essentially negligible.

AVR has been operating more or less continually since 1967 with funding assured to at least 1986 (Ref. 5). Further operation depends on a feasibility study now underway to help decide whether AVR should be modified for process heat development work. If such funding is approved, a separate process heat plant will be erected adjacent to the AVR reactor building. Tentative process heat plans call for demonstrating steam reforming via direct cycle, to be followed by installation of an intermediate heat exchanger to demonstrate steam gasification of hard coal.

C. Early Commercial MHTGR Proposals

KWU/INTERATOM

The first MHTGR to be explicitly designed to capture the two properties described above (zero public risk, low financial risk), was proposed by Drs. G.H. Lohnert and H. Reutler of KWU/Interatom (Ref. 6). The essential design features of this plant are shown in Figure 2. The core is designed to keep the peak fuel temperature below 1600°C for all plausible accident scenarios, including the simultaneous loss of coolant pressure and of control rod mobility (see Fig. 3). The fuel loading of the individual fuel spheres is limited to ensure that any reactivity increase due to water ingress can be compensated by inherent processes. The most obvious difference between the KWU design and other MHTGR designs is the side by side arrangement of the reactor core and the steam generator. Proponents claim this design has distinct and clear advantages with regard to design of the separate components, simplifies maintenance and repair, and results in low dose rates for routine operations and component replacement. There are also advantages claimed with respect to lower probability of water ingress and to the thermal decoupling of the core and steam generator. Associated disadvantages include possibly greater cost, possibly increased seismic vulnerability, and operational difficulties imposed by less efficient natural convection



TECHNICAL DATA

Thermal power	MW	200
Core diameter	m	3.0
Core height	m	9.6
Mean power density	MW/m³	3.0
Helium temperatures	°C	250/700
System pressure	bar	60
Number of control rods	-	6
Number of absorber ball systems	-	18
Diameter of pressure vessel	m	5.9
Height of pressure vessel	m	23.8
Loading scheme	-	RESHUFFLING
Fuel cycle	-	U/Pu
Heavy metal loading of fuel-element	g	7
burnup	MWd/t	80.000
Fuel incore time	d	1.020
Conversion	-	0.47
Enrichment	%	7.8
Fast Neutron Dose (E ≥ 0.1 MeV)		
Fuelelement	$10^{21}/cm^2$	2.2
Side reflector	$10^{21}/cm^2a$	0.6
Fissile material in core	kg	94
Control margin	nile	1
Shut-down requirement	nile	9

1	Pebble-bed	8	Core vessel
2	Pressure vessel	9	Coolant channel
3	Fuel discharge	10	Side reflector
4	Small-pebble-absorber system	11	Hot gas duct
5	Reflector rod	12	Wall-cooler
6	Fuel loading	13	Insulation
7	Thermal shield	14	Concrete cell

FIGURE 2. HTR-Module, KWU/Interatom

[From Ref. 6]

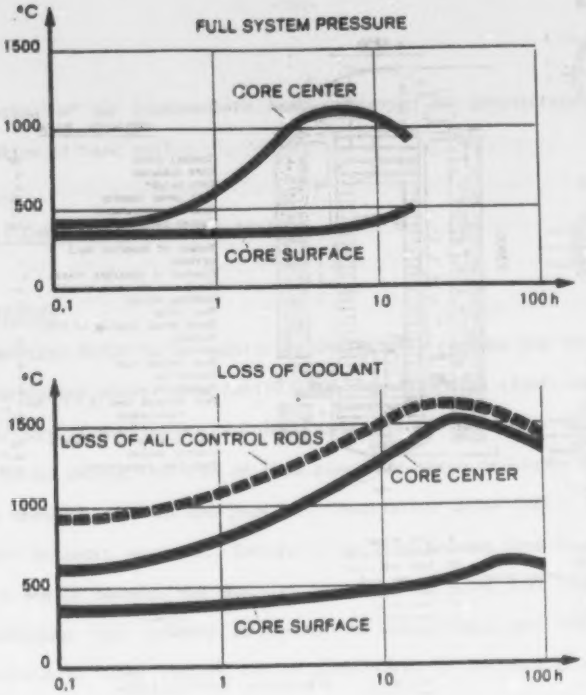


FIGURE 3. Time dependent maximal fuel-element temperatures under accident conditions for HTR-module.

[From Ref. 6]

cooling systems. KWU/Interatom is actively proposing this plant design for near-term commercial introduction for electricity and co-generation purposes.

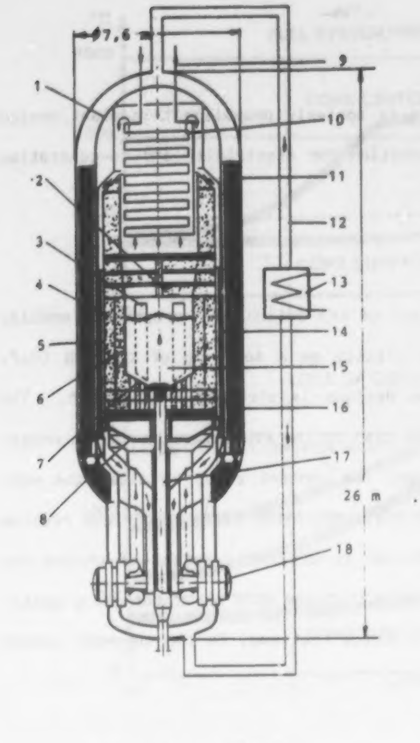
BBC/HRB

Drs. J. Singh and H. Barnert of KFA-Julich have proposed a modular design for the HTR based very closely on a scale-up of the AVR (Ref. 7). The similarity of the two designs is stressed in Figure 4. The core diameter is somewhat larger than in the KWU/Interatom design necessitating four internal buttresses for control rods, to allow the necessary control margin. BBC/HRB claim the large scale pebble-bed reactor exemplified by the proposed HTR-500 is still the option of choice for electricity production but believes that the MHTR has interesting possibilities in the near term for district heat and, in the somewhat longer term, for industrial process heat.

These two design variants are being reviewed in the U.S. Department of Energy-supported MHTGR design evaluation (Sec. 3.B).

D. Conceptual Design Evolution

As interest in the modular high temperature gas-cooled reactor concept developed in Germany and in the U.S., various design options were proposed and investigated. The basic idea of passive safety imposes certain requirements on the size and power density of the module. As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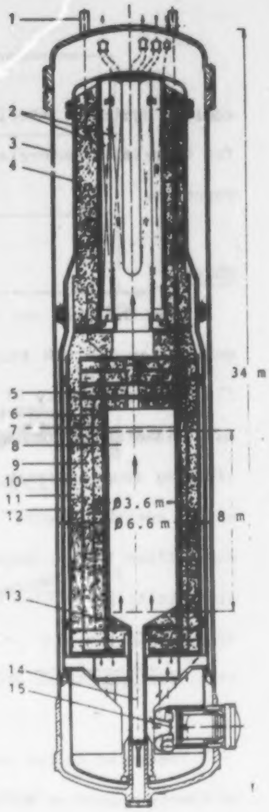
AVR-50-Reactor Design

1 inner reactor vessel
2 top reflector
3 shutdown rod nose
4 structural jacket
5 reactor sleeve
6 side reflector
7 reflector bottom
8 supporting structures
9 live steam pipe
10 steam generator
11 outer reactor vessel
12 barrier gas duct
13 barrier gas cooler
14 thermal shield
15 pebble bed core
16 biological shield No.1
17 sphere discharge tube
18 circulator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AVR-250-Reactor Concept

1 rod drive
2 steam generator
3 steel pressure vessel
4 core vessel
5 top reflector
6 KLAK-system
7 shut down rod
8 pebble bed core
9 side reflector
10 carbon structural jacket
11 thermal shield
12 insulation
13 bottom reflector
14 sphere discharge tube
15 circulator

FIGURE 4. BBC/HRB Reactor Module [From Ref. 7]

shown in Figure 5, assigning a maximum value to the peak fuel temperature during a depressurized core heat-up gives a relation between the module total thermal power and the power density. The maximum allowable temperature usually chosen is 1600°C; this value is determined by fuel quality and is expected to increase. The design task is to determine the most competitive reactor possible within the design envelope set by passive safety requirements.

These considerations led to the selection of the two primary MHTGR pebble bed (on-line refueling) design concepts that were introduced in the last section. The reactor cores are quite similar; the mechanical arrangements quite different. One concept involves the single steel vessel with the steam generator(s) "in-line" above the pebble-bed core as exemplified by the BBC/HRB design. The second concept involves the use of two steel vessels "side-by-side" such that the steam generator(s) are in a separate vessel located to one side of the core vessel as exemplified by the KWU/Interatom design. The in-line design arrangement simplifies the vessel and installation, the side-by-side simplifies the vessel internal design and maintenance. The AVR is a good example of an in-line system while the Peach Bottom HTGR may be considered the first example of a side-by-side design.

The pursuit of MHTGR designs has led to some interesting alignments of efforts between companies, both in Germany and in the U.S. These alignments have changed with time and are continuing to evolve. The

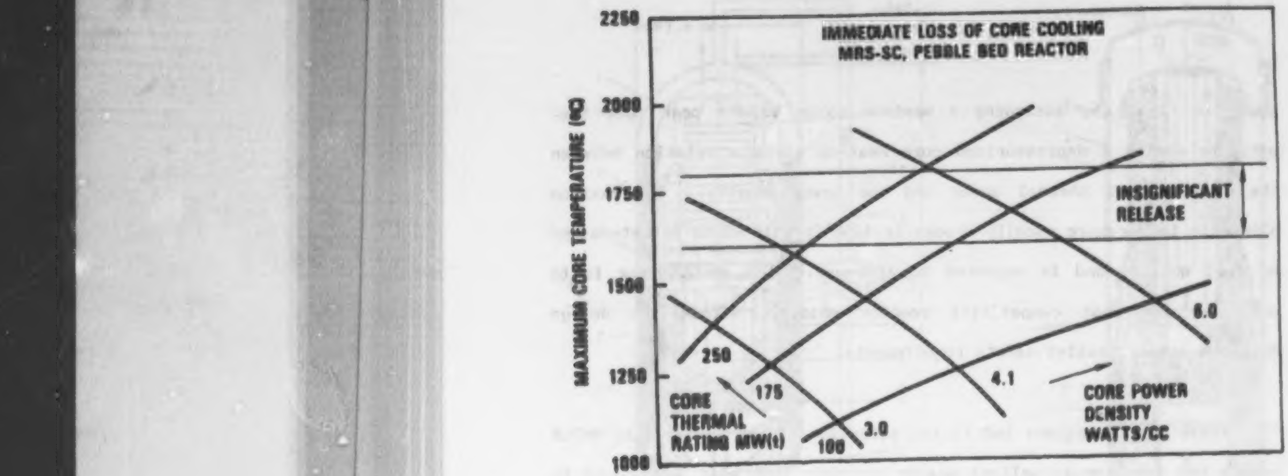

FIGURE 5. Modular Reactor Depressurized Core Parameters.

[From Ref. 8]

initial, pre-1980 goal in Germany for the use of the modular pebble-bed HTGR was the development of a versatile, very high temperature (approaching 1000°C outlet temperature) nuclear system for process heat, aimed at such industrial processes as the steam reforming of methane. Kraftwerk Union/Interatom originated this concept and was subsequently joined by General Electric in the U.S. Their joint studies, based on experience with the AVR pebble-bed reactor, initially involved an in-line design. However, after further study, the designs evolved toward side-by-side concepts. Some development of high temperature material would be required for 1000°C temperature operations.

By 1983, several groups, primarily in the U.S., began to wonder if the collapse of orders for nuclear plants might not actually be a window of opportunity for the commercial development of improved reactors. These potentially more acceptable plant designs would then be available for the next generation of nuclear plants to be ordered. The modular HTGR with its passive safety features was one obvious target for such efforts. In this application, the requirement for exit temperatures of about 700°C is ample for high thermal efficiency (~40%) in the production of electricity by conventional steam cycle. HTGR systems for this temperature range have been developed by General Atomic Co. and licensed in the U.S., at Peach Bottom I and Fort St. Vrain. (These were pyrolytically-coated-fuel reactors of 115 and 842 MWth respectively).

Another study led by GA Technologies (Ref. 8) utilized the base of pebble-bed reactor technology available through HRB, which is 45% owned by GA Technologies and 55% by Brown Boveri Company. This study of an in-line design also drew on HTGR technology supported by the U.S. Department of Energy (DOE).

An important study entitled "Evaluation of Small Modular High Temperature Gas-Cooled Reactors Applied to Electricity Generation" (Ref. 9) was sponsored by the Pacific Gas and Electric Company, supported and coordinated through the Gas-Cooled Reactor Associates (GCRA) and led by Bechtel Group Incorporated. A major contribution to this report was made by HRB, which developed the NSSS design with contributions from GA Technologies. (Section 4.A contains a brief review of the results of the PG&E supported study.) Both the vertical in-line construction and the use of passive safety features allow considerable simplification in the construction and operation of the complete nuclear plant (NSSS and BOP), with attendant potential for cost reduction. Use of the nuclear island concept, with the balance of plant built to fossil system standards, results in plants that are estimated to be competitive with similar sized coal plants when multi-modular plants are considered. However, it should be noted that HRB still believes that the economy-of-scale will be dominant, at least for German conditions, and although it is willing to cooperate in modular reactor development, it regards an extension of the THTR-300 (~750 MWth) line to larger units (1250 MWth) as more appropriate, even though these would exceed passive safety conditions.

Thus, during the summer of 1984 two concepts, in-line and side-by-side, each using the base technology available in Germany, were being promoted by different companies in Germany aligned with different companies in the U.S. These commercial arrangements are continuing to evolve and somewhat larger consortia are presently under consideration. There are also somewhat different objectives for the deployment of the two concepts. The in-line design is proposed for near-term competition with coal-fired production of electricity, the side-by-side concept could also be used for production of electricity, but its proponents express greater interest in the development of a higher temperature capability for process heat use. The present U.S. DOE program is described in more detail in Section 3.B.

3. CURRENT HTGR PROGRAMS

A. Foreign HTGR Programs

Gas-Cooled Reactor Associates publishes, at approximately yearly intervals, a compilation of summary-level information regarding the status, objectives, budget, facilities, etc. of major foreign gas-cooled reactor programs. The most recent compilation (Ref. 10), dated August 1984, shows only the Federal Republic of Germany and the USSR to have noteworthy programs in pebble-bed reactor technology. The Japanese gas reactor program is concerned exclusively with the prismatic fueled VHTR, a 50 MWt experimental process heat reactor now in the detailed design phase.

Federal Republic of Germany

The Government-supported HTGR program in the FRG is based on the development of pebble-bed technology for process heat applications. In addition, there is a growing interest on the part of some utilities and vendors in smaller scale pebble-bed reactors for electricity and co-generation applications. Modular reactors emphasizing passive safety are a recent development and their status within the overall plan is still uncertain. Table 1 is a comparison of the major German HTR projects.

In a recent report prepared by KFA-Julich for the Ministry of Research and Technology (Ref. 11), it was stated that, "the status of the HTR development program in the Federal Republic of Germany in 1984 is characterized by the beginning of a transition phase from a national program to a commercial program." For the past 20 years, the HTR program was almost entirely supported by the Federal government and the state government of North Rhine, Westphalia. This support allowed the building of an industrial infrastructure, supported KFA-Julich in r.&d. activities as well as in the construction and operation of AVR, provided the bulk of the funding for completion of THTR-300, and funded the construction and operation of several test facilities. It is now official policy that HTR technology is sufficiently mature that it is ready for commercial deployment.

The current, apparently well-ordered, status of the German program was occasioned by a response to a crisis several years ago, brought

	AVR	HTR-100*	HTR-MODUL**	THTR-300	HTR-500
Thermal Power, MW	46	256	200	750	1250
Net Electric Power, MW	13	100	80	300	500
Avg. Power Density, MW/m^3	2.5	4.2	3.0	6.0	6.0
Hot Helium Temperature, °C	950	700	700	750	700
Helium Pressure, MPa	1.1	7.0	6.6	3.9	5.0
Steam Temperature, °C	505	530	530	530	525
Steam Pressure, MPa	7.4	19.0	19.3	18.0	18.0
Pressure Vessel	Steel	Steel	Steel	PCRV	PCRV
Helium Flow Direction in Core	Up	Up	Down	Down	Down
Number of Loops	1	3	1	6	8
Fueling Cycle	Recirculating	Recirculating	OTTO***	Recirculating	OTTO

* BBC/HRB

** KWU/Interatom

*** Once through (the core) then out

TABLE 1. COMPARISON OF DIFFERENT GERMAN HTR CONCEPTS

[From Ref. 10]

about by the unexpectedly large incremental costs necessary for completion of THTR-300. It became clear that THTR-300 could be completed only if a compromise was reached between the federal and state governments and the interested utilities and vendors. As part of these discussions, it was also agreed that the HTR program would be continued provided that industry take over the lead role and assume responsibility for further technology development. The HTR-500 is now the main focus of the program. It was further agreed that industry would take the lead in further prototype plant development for process heat applications also.

The major program elements and their time schedules are shown in Figure 6. The logical basis of the program is that early in 1986 there should be available information regarding:

- Feasibililty and cost of AVR modification for process heat development work;
- THTR commissioning and operational experience;
- Commitment for a THTR successor plant;
- Lead project definition for the nuclear process heat program; and
- Fully "mature" fuel manufacturing processes for low enriched uranium fuel cycles.

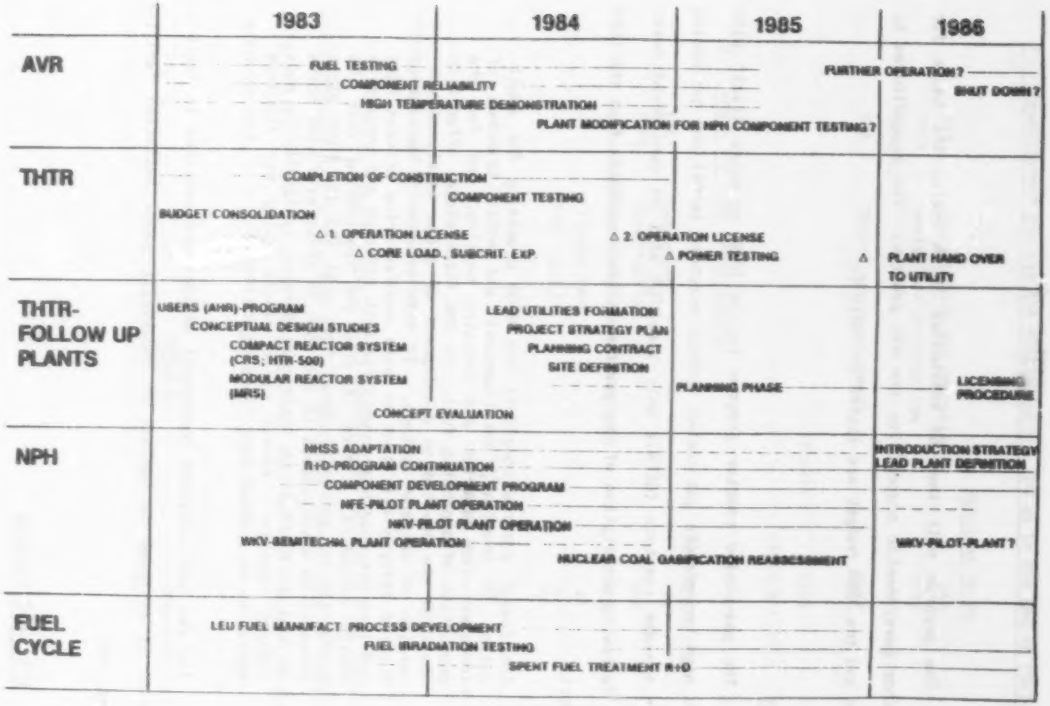
1983
1984
1985
1986
AVR
FUEL TESTING
COMPONENT RELIABILITY
HIGH TEMPERATURE DEMONSTRATION
PLANT MODIFICATION FOR NPH COMPONENT TESTING?
FURTHER OPERATION?
SHUT DOWN?
THTR
COMPLETION OF CONSTRUCTION
COMPONENT TESTING
BUDGET CONSOLIDATION
△ 1. OPERATION LICENSE
△ CORE LOAD., SUBCRIT. EXP.
△ 2. OPERATION LICENSE
△ POWER TESTING
△ PLANT HAND OVER TO UTILITY
THTR-FOLLOW UP PLANTS
USERS (AHR)-PROGRAM
CONCEPTUAL DESIGN STUDIES
COMPACT REACTOR SYSTEM (CRS; HTR-500)
MODULAR REACTOR SYSTEM (MRS)
CONCEPT EVALUATION
LEAD UTILITIES FORMATION
PROJECT STRATEGY PLAN
PLANNING CONTRACT
SITE DEFINITION
PLANNING PHASE
LICENSING PROCEDURE
NPH
NHSS ADAPTATION
R+D-PROGRAM CONTINUATION
COMPONENT DEVELOPMENT PROGRAM
NFE-PILOT PLANT OPERATION
NKV-PILOT PLANT OPERATION
WKV-SEMITECHN. PLANT OPERATION
NUCLEAR COAL GASIFICATION REASSESSMENT
INTRODUCTION STRATEGY
LEAD PLANT DEFINITION
WKV-PILOT-PLANT?
FUEL CYCLE
LEU FUEL MANUFACT. PROCESS DEVELOPMENT
FUEL IRRADIATION TESTING
SPENT FUEL TREATMENT R+D

FIGURE 6. FRG-HTR-Program-Elements [From Ref. 11]

The program will then be reexamined to determine the basis for further governmental support for the HTR program. The expenditures to date and the 1984 budget are listed in Table 2.

USSR

The gas-cooled reactor program in the USSR concerns itself with both high-temperature gas-cooled thermal reactors (HTGR) and gas-cooled fast breeder reactors (GCFR); only the HTGR will be considered here. The following description of the program is taken verbatim from the GCRA report:

> The Soviet program considers the HTGR promising for application in chemical, metallurgical and other branches of industry, for district and industry heating, and for the production of synthetic fuel. As the first stage, efforts in the USSR are devoted to development of steam catalyzed conversion of methane systems. If this process is successful further efforts will look to both manufacturing process heat and long distance heat supply for both district and industrial energy consumers. There is also the realization that the production of synthetic fuels from coal via the HTGR might prove to be advantageous in the USSR in areas with high costs of coal or where large scale coal burning is limited by ecological reasons. Direct cycle plants using gas turbines appear to be another long range objective.

The two most advanced conceptual designs are compared in Table 3. VGR-50 is designed to include an industrial gamma radiation facility (Ref. 12).

B. U.S. HTGR Program

The present U.S. program in HTGR technology is primarily supported by the U.S. DOE with some additional support from utilities and vendors

1. Expenditures* for the HTR Program in the FRG up to the End of 1983:

		Millions of DM
AVR	Construction and Operation	243
THTR	Design and Construction	2745
General		
HTR	Technology Development	2332
	Total:	5320
		($2.2 billion)

2. Budget for 1984 (Preliminary)

		Millions of DM
AVR	Operation	16
THTR	Construction	648
HTR Technology	NHS, Components, Materials	159
	Process Heat	46
	Fuel Cycle	31
	Total:	900
		($321 Million at 2.8 DM/$)

---

*From public and private sources

The HTR-100 modular reactor being developed by BBC/HRB and the reactor-modul proposed by KWU/Interatom are both privately funded, thus no estimate is available of the financial support level for the two projects of most relevance here.

TABLE 2 [From Ref. 11]

	VGR-50	VG-400
Power	50 MW(e)	1000 MW(t)
Helium Temperature:		
at reactor outlet	810°C	950°C
at reactor inlet	280°C	350°C
Helium Pressure	4,0 MPa	5 MPa
Core Size	D/H 2.8/4.0 m	6.4/4.8 m
Fuel Element	60 mm sphere	60 mm sphere
Number of Fuel Elements:		
in the reactor	125,000	8.10^5
in installation	300,000	
Fuel Enrichment	21 %	6.5 %
Average Burnup	100,000 MW day/t	70,000 MW day/t
Core Lifetime	(?)	~ 320 eff. days
Number of Cooling Loops	4	4
Gamma Power Radiation Circuit	300-400 kW	
Steam Parameters:		
Pressure	9 MPa	17.5 MPa
Temperature	535°C	535°C
Reactor Pressurized Vessel	steel	Reinforced Concrete

TABLE 3. MAIN CHARACTERISTICS OF VGR-50 AND VG-400

[From Ref. 12]

through the Gas-Cooled Reactor Associates, and from the Nuclear Regulatory Commission (NRC) for programs related to future licensing. Support by DOE goes primarily to Oak Ridge National Laboratory (ORNL) and to GCRA coordinated programs. These include work at GA Technologies, General Electric (Sunnyvale), Combustion Engineering, Bechtel, Stone & Webster, and by other smaller assessment study groups such as M.I.T. ORNL is making an independent assessment of various concepts, and Brookhaven National Laboratory is working on the NRC supported program. GA Technologies has the primary base of the technology and continues to work on private and internally funded programs such as Fort St. Vrain support in addition to the DOE supported program.

Although there are general expressions of interest in the HTGR programs on the part of vendors and utilities, the current program is primarily funded by the DOE. It is believed by many people that the development of a commercial MHTGR is dependent upon the construction and operation of a demonstration plant. It is further believed that such a plant will be built only if it is supported by the government. Thus, the DOE program that is now in progress has as its goal the selection of the design concept that will be recommended to the government for construction of a commercial development plant.

The DOE program encompasses a trade-off and selection study for a wide variety of HTGR designs that might be used to produce electricity in the 400 to 600 MWe range from a given plant. Concepts considered in this study include geometry-constrained cores (e.g., cores with large surface-to-volume ratios such as the thin cylinder (modular) HTGR and the annular core HTGR) that are passively safe, and large integrated cores that utilize active components for safety. Prismatic (Fort St. Vrain type) fuel blocks and pebble-bed cores have been compared, as well as prestressed concrete vessels and steel vessels. Beginning in the spring of 1984 some 16 separate design concepts were evaluated. By the fall of 1984 this array of concepts was reduced to four. The selection of the four was, in part, based on an industry-agreed-upon list of "musts," i.e., requirements that each concept must meet, and "wants," a list of attributes that could be used to compare the desirability of the various concepts. Figure 7 is a typical listing of the 'Musts' and 'Wants' as enumerated by the DOE (Ref. 13). The four concepts that are now being studied in further detail are:

- In-Line Steel Vessel (250 MWt/100 MWe) - Upflow pebble-bed reactor in a lower steel pressure vessel with two steam-generators and circulators in an upper steel vessel connected in-line with a flanged seal. The plant is to consist of multiple units that may be built as a cluster or sequentially.
- Side-by-Side Steel Vessel (200 MWt/80 MWe) - Downflow pebble-bed core in a steel vessel connected by a concentric pair of ducts to an adjacent steel vessel containing one steam generator and circulator. As above, the plant is to consist of multiple units that may be built as a cluster or sequentially.

HTGR CONCEPT EVALUATION STEPS:

1. Define major barriers to future introduction of nuclear power.
2. Identify "musts" criteria within barriers.
3. Identify "want" attributes and weighting.
4. Screen concepts against "musts".
5. Rank concepts against identified "wants".

SUMMARY OF "MUSTS":

1. Economics................ costs are too high
2. Economic Uncertainty..... costs are too uncertain
3. Regulatory Uncertainty... licensing process is unpredictable
4. Public Acceptance........ public is skeptical that plants are safe
5. Utility Acceptance....... need smaller plants for current institutions
6. Government Acceptance.... high development costs

SUMMARY OF "WANT" ATTRIBUTES:

A. Development
B. Engineering
C. Fabricability
D. Constructability
E. Maintainability
F. Availability
G. Operability
H. Licensability/Safety
I. Marketability
J. Fuel Cycle
K. Decommissioning

FIGURE 7. U.S. DOE PROGRAM OVERVIEW

[From Ref. 13]

- Annular Core in Multi-Cavity PCRV (1260 MWt/460 MWe) - Annual prismatic-block core in a multi-cavity PCRV with 4 steam generators and circulators, plus 2 natural-circulation auxiliary cooling loops in cavities surrounding the core cavity.
- Conventional Core in Multi-Cavity PCRV (1170 MWt/430 MWe) - Prismatic core in asymmetric, multicavity PCRV with 2 steam-generators and circulators plus 2 forced circulation loops and one natural circulation auxiliary loop within the PCRV.

It is expected that further reductions in the number of concepts will be made early in 1985 and the final design selection will be made by Fall 1985. The next phase would be to make detailed designs for a demonstration plant of the selected design concept.

4. PROSPECTS FOR THE MHTGR

A. Potential Impact

The highest immediate potential for the MHTGR in the United States is as a nuclear steam supply system of choice for new central station electric power plants. The best evidence that this can actually be attained is provided by the previously cited Pacific Gas and Electric Company study which was explicitly aimed at determining the potential of the modular HTGR as a near-term electricity generating option. The reactor used as the basis of the study was the "HTR-100 "Module" designed by HRB. HTR-100 is a vertical in-line reactor with all major access and repairable components located near the reactor top. This geometry makes HTR-100 particularly suitable for deployment in underground silos, a major feature of the conceptual plant design. The PG&E study concentrated its attention on a two-module plant generating 200 MWe, although single and four module units were also considered by extrapolation. Figure 8 and 9 show the plant layout; Table 4 lists important reference plant characteristics. A key design feature is the use of confinement buildings rather than containment buildings for the reactors. This choice is justified by calculations showing that even pessimistic estimates of the radioactivity which might be released to the environment in an uncorrected core heatup accident are orders of magnitude below the limits imposed by 10 CFR-100. These estimates are based on data developed for present day pebble-bed fuel, with no allowance made for such mitigating factors as plate-out or filtration. No claims were made with respect to the possibility of significantly higher-performance fuel although there is laboratory evidence demonstrating that such fuels will eventually be available at possibly minimal extra cost. The technical basis for the important assumption of confinement rather than containment structures thus appears quite sound.

An important factor affecting the estimated cost is a plant design that makes it possible to keep "Nuclear Grade" field work to a minimum. Shop fabrication of the NSSS is an obvious contributor to this goal.

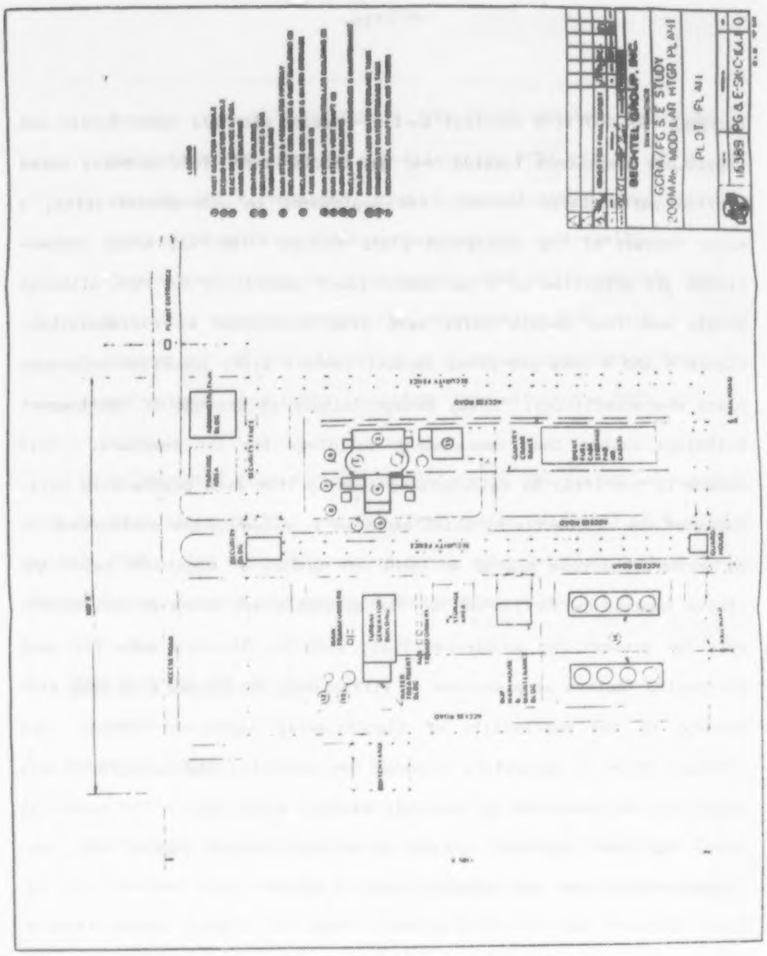
BECHTEL GROUP, INC.
GCRA/PG&E STUDY
200MWe MODULAR HTGR PLANT
PLOT PLAN
16389 PG&E-SK-C-64 0

FIGURE 8. GCRA/PG & E Study, 200 MWe Modular HTGR Plant, Plot Plan

[From Ref. 9]

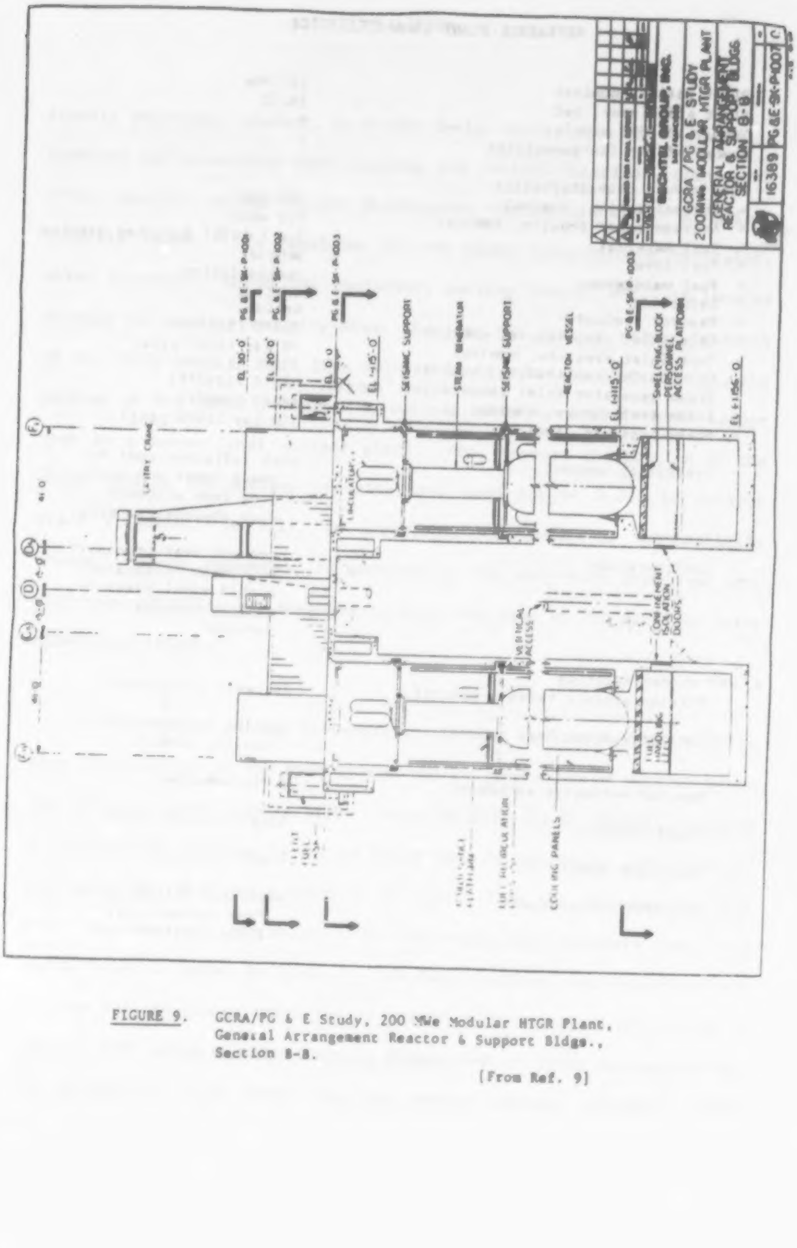
GCRA / PG & E STUDY
200MWe MODULAR HTGR PLANT
GENERAL ARRANGEMENT
REACTOR & SUPPORT BLDGS
SECTION B-B
BECHTEL GROUP, INC.
16389
PG&E-SK-P007
C
SEISMIC SUPPORT
STEAM GENERATOR
SEISMIC SUPPORT
REACTOR VESSEL
SHIELDING BLOCK
PERSONNEL ACCESS PLATFORM
CONTAINMENT ISOLATION DOORS
VERTICAL ACCESS
COOLING PANELS
FUEL HANDLING
EL 0'-0"
EL 20'-0"
EL 30'-0"
EL (-)15'-0"
EL (-)115'-0"
EL (-)156'-0"

FIGURE 9. GCRA/PG & E Study, 200 MWe Modular HTGR Plant, General Arrangement Reactor & Support Bldgs., Section B-B.

[From Ref. 9]

REFERENCE PLANT CHARACTERISTICS

o Plant rating, nominal	197 MWe
o Plant efficiency, net	38.5%
o Number of NSSS modules	2
o Number of turbine-generators	1
o NSSS module characteristics	
- Thermal rating, nominal	256 MWt
- Average power density, nominal	4.2 w/cc
- Fuel material	low (< 10%) enriched uranium
- Fuel type	pebble
- Fuel management	recirculation
- Refueling	on-line
- Reactor coolant	helium
- Core inlet temperature, nominal	260°C (500°F)
- Core inlet pressure, nominal	70 bar (1000 psia)
- Core outlet temperature, nominal	730°C (1350°F)
- Steam generator inlet temperature, nominal	700°C (1290°F)
- Steam temperature, nominal	530°C (990°F)
- Steam pressure, nominal	190 bar (2800 psig)
- Reactivity control	with reflector rods for power level and scram; long term shutdown with absorber spheres
- Configuration	core and heat transport equipment integrated within steel pressure vessel, vertical in-line
o BOP characteristics	
- Fission product release control	filtered confinement
- Emergency decay heat removal	reactor enclosure wall cooling panels
- Reactor enclosure embedment	fully embedded
- Plant control	single control room
- Auxiliary power	2 gas turbines
- Construction approach	separated nuclear-grade from conventional field construction

TABLE 4. [From Ref. 9]

Equally important, however, is a site design that places the two modular reactors and associated fuel handling and control buildings, along with other required nuclear island maintenance facilities, within a nuclear security fence. The remainder of the plant (the turbine generator, water treatment, electrical equipment, cooling towers, etc.) is located outside the nuclear security area. Because the passive safety features of the MHTGR make it much less vulnerable to external disturbances, the portion of the plant outside the nuclear security area is much larger than in a conventional nuclear plant. And, because the portion of the plant outside the nuclear security area need not be built to nuclear grade standards, it will, as experience has shown, be substantially cheaper. These economies, in addition to the very much shortened construction schedule, are expected to more than make up for possible scale diseconomy effects.

A significant saving of construction time is attributable both to shop construction of the NSSS system and to separation of nuclear grade and standard grade construction. Detailed analysis by Bechtel predicts a construction schedule (start of field work to commercial operation) of just over two years and a total of 54 months from the start of the project to commercial operation. The resulting cost estimate for a two module plant is shown in Table 5. The total capital requirement is $438 million for the plant, resulting in a unit capital cost of $2,230/kwe in January 1984 dollars. This figure, independent of other considerations, is competitive with other possible energy sources including larger

2-256 MWt Reactor Modules
1-197 MWe Turbine Generator
(January 1984 $ Million)

Acct.	Category	NSSS	- BOP -		TOTAL
			Nucl	Conv	
21	Structures and Improvements	-	20	10	30
22	Reactor Plant Equipment	110	10	-	120
23	Turbine Plant Equipment	-	-	45	45
24	Electric Plant Equipment	-	17	9	26
25	Miscellaneous Plant Equipment	-	3	3	6
26	Main Condenser Heat Rejection System	-	-	6	6
	Total Direct Cost	110	50	73	233
	Construction Services and Field Engineering	0	48	11	59
	Total Field Costs	110	98	84	292
	Engineering, Home Office Services and Fees	0	31	8	39
	Owner's Cost	11	13	9	33
	Subtotal	121	142	101	364
	Contingency	24	28	10	62
	Total without Allowance for Funds During Construction (AFDC)	145	170	111	426
	AFDC	4	5	3	12
	Total Capital Requirement for an Equilibrium Plant	149	175	114	438
	Unit Capital Cost				($2230/kWe)

TABLE 5. Two Module Plant Capital Cost Estimate Summary

[From Ref. 9]

nuclear plants and coal-fired plants. However, as the work by Decision Focus has shown (Ref. 14), there are substantial additional effective "credits" that can be taken, by both shareholder and ratepayer, for size optimization and short lead time. These credits are particularly significant when comparing MHTGR systems with the much larger LWR systems that claim economies of scale. The MHTGR clearly has at least the potential of providing a new nuclear option, acceptable both to the public and to the utilities and competitive with coal, for both new and replacement power at the turn of the century.

B. Outstanding Technical Issues

In principal, there are no outstanding technical issues that might prevent commercialization of the MHTGR. Two HTGRs have already been licensed and operated in the U.S.; Peach Bottom I and Fort St. Vrain. Although these reactors both use encapsulated fuel in prismatic blocks and although they take advantage of the forgiving nature of all graphite reactors, they are not passively safe in the sense used here. Nonetheless, the Fort St. Vrain reactor has been licensed for operation with a confinement (not containment) building. Licensability with confinement structures is believed to be a necessity for commercial viability.

However, when viewed with regard to optimizing and commercializing the passively safe MHTGR design selection, there remains a number of unresolved or undemonstrated technical issues:

(1) Demonstration of the Passive Safety Feature:

Licensing with no public evacuation zone.

(2) Demonstration of competitive cost:

Demonstrate low cost uncertainty and low financial risk, including high availability and recoverability for a large spectrum of incidents. Cost of product must include capital cost; fuel cycle cost, including waste disposal; operation and maintenance; and decommissioning.

(3) Design Issues:

- Vertical in-line versus side-by-side vessel design decision.
- Core design and safety issues:
  - Particle fuel fission product retention: what is the maximum transient temperature that will not exceed the passive safety criteria (time and temperature limits for a given transient with the primary system either pressurized or unpressurized)?
  - Reactivity effect of water ingress, including control rod effectiveness changes -- (design limitation such as loading per ball, limiting burnup).
  - Fuel and waste disposal.
  - Air ingress: what are the probabilities and consequences? Should more design consideration be given to oxidation mitigation or can this accident be proven to be inconsequential?

- Separation of the nuclear island from the construction of the balance of plant.
- Control of multi-module systems from one control room.
- Step wise investment
    - Operation of some modules while other modules are being installed or maintained.
- Temperature cycle limits: what are the limits on frequency and temperature for transient cycles of the vessel and components such as the steam generator? Also, what are the costs of environmental qualifications for all components in the reactor cavity -- sensors, cables, motors, etc. and control materials?

(4) Factory fabrication and serial production versus on-site modular construction practices (factory at the site).

(5) NRC licensing must allow credit for passive safety for simplification of safety systems and licensing processes.

The first item in this list, Demonstration of Passive Safety, is believed by some to be important in order to convince the public and utility purchasers that passive safety is possible. On the other hand, others argue that most of the features of passive safety have been demonstrated by the AVR experience and that the physics of thermal heat transfer are well enough understood to assure the design concept.

The second item, Economic Demonstration, is a most important issue: many of the items under core design and safety actually pertain

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indirectly to the economic issue. In addition to the fundamental requirement of competitive cost of product, the system must be reliable and must easily recover from anticipated transients, such as loss of feedwater. Some of these transients could potentially cause severe temperature cycling due to rapid heat transfer either by the circulators or by natural circulation. Although there are no public safety questions, there might be financial risk and availability questions if the design is not adequate and is not thoroughly demonstrated.

This list of issues can in large part be combined in the question: "Is there a need for a demonstration plant and if so what is to be demonstrated?" This question, now being faced by all of the proposed innovation concepts, is to be addressed specifically as part of the U.S. DOE program plan. The question is not easily answered but a few observations, common to most innovative options, can be listed here. Specific recommendation for the HTGR are reserved for Section 5 below.

- If passive safety is the primary purpose of the demonstration, then the demonstration plant does not need to be an exact replica of the future commercial plant.
- If competitive cost, low cost-uncertainty, low financial risk and licensability are to be demonstrated, the plant must be a close replica of the future commercial plant.
- The decision to build a demonstration plant will mean that the commercial plant is one step removed and cannot be available until the late 1990s at the earliest.

- There does not seem to be a vendor in the U.S. that is willing to take financial responsibility for commercializing the MHTGR concept without government funding.

C. Role of the NRC

New reactor concepts make all claims with respect to cost, construction time and operational simplicity subject to the constraints of "licensability." The need for this caveat is hard earned and will not soon be forgotten. If there is no explicit guarantee that the construction and ultimate operation of the plant will be approved, then no new reactor, conventional or improved, will be ordered by any utility. MHTGR licensing cannot follow the existing LWR model for this reason and because of the number of MHTGRs that will be manufactured. One possible revised licensing scheme is discussed below.

If the MHTGR becomes the reactor of choice then the anticipated demand will easily justify serial production techniques and multiple replication of identical units. For example, if each module is postulated to yield 100 MWe, then the median projection of 5000 MWe/yr. new nuclear baseload capacity in the period 2000-2010 (Ref. 3) corresponds to 50 modules per year. Surely, these need not be individually licensed and yet the public must be protected. A model solution to this problem has been developed to ensure public safety in air transportation. Following this model, the licensing agency would grant the required licenses to a class of identical reactors, that are built to certain standards (inspectors are in the plant), to be used within certain specified limits. The exact analogy is probably closest to the "airworthiness" certificate issued by the FAA but we will refer to this licensing method here as "type-licensing."

The standards for such type-licensing must be stricter than those now applied by the NRC because if a particular reactor is to be replicated then the consequences of a design error are potentially much larger, if not in public health, then in reliability of the nation's electricity supply. A simultaneous "recall" would be traumatic indeed. A more subtle reason is that commercial success of moderate size reactor systems will put reactors in the hands of many operating groups with varying levels of skill and training.

The NRC must, therefore, be absolutely certain that the reactor is as safe as its proponents claim. The solution in the case of the MHTGR is to subject a full-scale reactor to the Design Basis Accident or Accidents. The Design Basis Accident must, of course, include all worst case possible combinations of operator action and system failure. This is possible in the case of the MHTGR because the reactor will survive the design basis accident without either public or financial risk, and so a series of increasingly severe tests can be performed. In particular, it can and must be proved by demonstration that the proposed reactor can meet its design goals solely under the action of the inherent passive safety features. Such a demonstration will have the additional very important effect that it will convince the public and potential utility purchasers in a way that no calculation ever could.

Type-licensing in this fashion would eventually put fewer requirements on the NRC than does the current system, even though the standards to be met would be more stringent. There would need to be no detailed analysis of scaled test data, minimal reliance on detailed computations or computer simulations, and no need to pay extreme attention to the balance of plant because the safety envelope will have been shrunken to the boundaries of the NSSS. The NRC would, of course, have to maintain a fixed staff at the production sites but on-site inspection requirements would be drastically reduced.

It is neither likely nor desirable that a single vendor will supply the entire U.S. electric utility requirement. It is not necessary, however, that competition be foregone or that several vendors agree to build identical reactors. As in the aircraft industry the front-end capital costs associated with an efficient serial production facility will be large enough to provide a significant barrier to market entry. Only serious entrants to the market will finance construction of the full scale commercial prototype needed for type licensing. Nonetheless, the potential market is so large that three or four vendors could potentially co-exist profitably. It is unlikely that one manufacturer could maintain a monopoly status.

D. Considerations that Affect the Technical Choices Within the Overall Reactor Development Program

The technical choices within the Modular HTGR development program are being explored in detail within the present U.S. program. This program plans to arrive at a defendable HTGR concept to be recommended for commercialization to produce electricity. For consideration of the MHTGR relative to *other* reactor options the following ideas are presented:

(1) Deployment of the MHTGR for production of electricity can be viewed as part of a step-wise development of a high temperature nuclear heat source that can evolve to both electrical and process heat applications.

(2) Individual 250 MWth MHTGR modules require a pressure vessel that is equivalent in size to a 3000 MWth LWR vessel. This large MHTGR module size adds to the cost but is somewhat balanced by the fact that the large graphite volume makes the system response time slow and easy to control; in fact, these systems are particularly amenable to the use of closed-loop digital control systems.

(3) The pyrolytically coated fuel has a superior capability to retain fission products at high operating temperatures and high temperature transients.

(4) On-line refueling and the system simplification made possible by passive safety can be important contributors to plant high plant availability.

(5) The pyrolytically coated fuel is well-suited to a once-through fuel cycle.

5. WHAT NEXT?

The goal of the MHTGR program is the development of a type-licensed reactor-core/steam-generator combination supplied by a committed U.S. vendor. The direct path to this goal is fully government-funded construction of a "commercial-design" modular HTGR. There are various estimates of the total cost of a government-funded program aimed at bringing the MHTGR to commercialization: the median estimate is 500-800 million dollars. However, government funding for a commercial demonstration project of this magnitude appears to be an extremely unlikely event now or in the foreseeable future. The brief analysis below considers several suggested courses of action with due regard given to political and economic constraints.

The first key assumption in this discussion is that the NRC will type-license a unit only if:

(i) an exact full-scale reactor, a true prototype, has been submitted for tests;